DOCUMENT RESUME

ED 211 363 SE 036 039

AUTHOR	Pikaart, Len; And Others
TITLE	1981 Ohio Regional Conferences on Mathematics Education: Microcomputers in Education.
INSTITUTION	Ohio Univ., Athens. Coll. of Education.
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	81
GRANT	NSF-SER-8008906
NOTE	157p.; For 1980 Conference, see ED 200 421. Some journal articles deleted due to copyright restrictions. Contains occasional light and broken type.
EDRS PRICE	MF01/PC07 Plus Postage.
DESCRIPTORS	Computer Programs; Curriculum Development; Educational Technology; *Inservice Teacher Education; Junior High Schools; Mathematics Curriculum; Mathematics Education; *Mathematics Instruction; *Microcomputers; Middle Schools; *Resource Materials; Secondary Education; *Secondary School Mathematics; Teacher Education
IDENTIFIERS	BASIC Programing Language

ABSTRACT

Six regional conferences designed to provide educational decision-makers and teacher-leaders with a state-of-the-art review of the possibilities, limitations, and recent technology of microcomputers in an educational perspective were held in 1981. The purposes of the conferences were to: (1) stimulate realistic and effective approaches to using microcomputers in middle, junior high, and secondary schools; (2) provide hands-on experiences and demonstrations of microcomputers; (3) indicate the range of software available; (4) provide summaries of microcomputer research and project results; (5) distribute criteria helpful for selecting both hardware and software; and (6) maintain cooperative linkages between local school personnel and other mathematics educators. The majority of this document consists of materials distributed to conference participants. These materials were either developed by the project staff or written by others and reprinted with permission. (MP)

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1981 Ohio Regional Conferences on Mathematics Education

Microcomputers in Education

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Athens, Ohio
1981

SE 036 039

1981 Ohio Regional Conferences on Mathematics Education

Preface

"The National Council of Teachers of Mathematics recommends that . . . mathematics programs take full advantage of the power of . . . computers at all grade levels" (p. 1, NCTM An Agenda for Action, Reston, Virginia, 1980).

The professional uses of computers have been an interest for educators for more than two decades. With improved technology and the advent first of the minicomputer and more recently of the microcomputer, the notion of a computer in every school and every home has become more feasible. The revolution of microcomputers, with an industrial growth rate of 45% a year, has changed the whole perspective of computers in education during a period of only four years.

The current and proposed uses of computers in schools include: 1) computer awareness and literacy, 2) programming courses, 3) simulations, 4) problem solving, 5) computer assisted instruction (CAI), 6) computer managed instruction (CMI), and 7) administrative data processing.

Six regional conferences in mathematics education scheduled to be held in Ohio during 1981 are designed to provide educational decision-makers and teacher leaders with a state of the art review of the possibilities, limitations, and recent technology of microcomputers in an educational perspective.

The purposes of the conferences are:

*to stimulate realistic and effective approaches to using microcomputers in middle, junior high and secondary schools

*to provide hands-on experiences and demonstrations of microcomputers

*to indicate the range of software available

*to provide summaries of microcomputer research and project results

*to distribute criteria helpful for selecting both hardware and software

*to maintain cooperative linkages between local school personnel and other mathematics educators

Conference participants receive a packet of material about microcomputers and the educational uses of microcomputers in schools. These materials were either developed by the project staff or written by other people and reprinted here with permission. All the papers were selected as resource material for the participants to use when they conduct in-service activities. Permission to copy any materials in the packet which are not copyrighted is accorded to educators for use in pre-service and in-service educational activities.

Conference Sites

Columbus	May 8-9, 1981
Cincinnati (Princeton School System)	May 14-15, 1981
Berea (Baldwin Wallace College)	September 28-29, 1981
Bowling Green (Bowling Green State University)	October 14-15, 1981
Athens (Ohio University)	October 29-30, 1981
Canton	November 12-13, 1981

7/28/81

1981 Ohio Regional Conferences on Mathematics Education

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An Outline of Computer History

Although much of the progress made in computing technology has been in the last forty years, to trace significant developments in the history of computing one must go back nearly 5000 years. For most of this time progress was sporadic. As early as 3000 B.C. different versions of the abacus (Russian, Chinese, or Japanese) were used as computing devices. In fact, in some parts of the world, they are still used today. The only other B.C. development noted in most history of computing accounts is the digital machine used by the Greeks for astronimical calculations in 30 B.C.

The next accomplishment was not until the fourteenth century when an Iranian astronomer and mathematician, Jamshid ben Mad'ud ben Mahmud Ghiath ed-Din al-Kashi invented a planetary computer to compute the longitude of the sun, moon, and some planets. Three hundred years elapsed before another development occurred. In the early sixteen hundreds John Napier, a Scottish mathematician, developed a set of rods known as Napier's Bones that could be used for calculating with large numbers. Napier also invented logarithms which made it possible to multiply and divide by adding and subtracting. The use of logarithms led to the development of the slide rule in 1630. Another seventeenth century accomplishment was a calculating machine that would add and subtract, developed by Blaise Pascal in 1642 to help with the adding of columns of numbers in his father's tax accounting office. However, in 1671 Gootfried Wilhelm Leibniz invented the Leibniz Wheel that would multiply and divide as well as add and subtract.

The next breakthrough was not until 1801 when Joseph Jacquard, a French loom maker, developed a system for storing information and relaying information to a machine (in his particular case to a loom) via punched cards. Essentially, Jacquard used the binary system that is still used today in many machines.

The "Father of Computers" is often said to be Charles Babbage who, in 1822, invented the difference engine that he thought would end tedious calculations forever. He received a grant from the British government to build his engine in 1823, but never finished it because he kept changing the design. The difference engine was finally built in 1854 but by a Swedish gentleman. However, Babbage did invent a stored-program digital computer in 1833 known as the analytical engine. The analytical engine could be controlled by punched cards and in many ways was more complex than today's computers.

Further progress was made in 1890 when Herman Hollirith used Jacquard's loom principle to record U.S. census information on punched cards. Hollerith also developed a machine to read the punched cards. With Hollerith's cards and machine, the 1890 census information was tabulated in 2 1/2 years instead of the 9-10 years expected to do such tabulation manually. Hollerith organized the Tabulation Machine Company which made his machine available to the general public. Later his company merged with International Business Machines (IBM).

In the twentieth century amazing progress has been made. The first general purpose computer was completed in 1944 by Professor Aiken of Harvard University. This computer was called the Automatic Sequence

Controlled Calculator or, more commonly, Mark I. The Mark I was a significant development in that it combined memory and a processing system. This basic concept of computing has remained the same. The job now was to increase the speed of information storage, retrieval and processing.

The first electronics digital computer was developed by Dr. John Mauchly and J. Prespep Eckert at the University of Pennsylvania in 1946. Some say that Mauchy and Eckert actually got the idea for their computer from John V. Atansasoff and Clifford Berry who had shown Mauchly an uncompleted computer in 1941. The Mauchly-Eckert computer was called the Electronic Numerical Integrator and Calculator (ENIAC). This machine needed approximately 1500 sq. ft. of floor space and weighed 30 tons. While it was thought to be able to do calculations at an amazing speed in that day, it had less memory and was slower than some of today's hand-held calculators.

In 1946, Dr. John von Neuman, a Princeton University mathematics professor, suggested two improvements to the ENIAC. First, he suggested that binary numbers (such as Jacquard used) had some advantage over the decimal system used in the ENIAC. Secondly, he proposed that instructions to the computer could also be stored. Hence, the idea of programming was born. The Electronic Delay Storage Automatic Calculator (EDSAC) was built at Cambridge University in England in 1949 to incorporate Van Neumann's ideas. Mauchly and Eckert produced another computer in 1952, the Electronic Discrete Variable Computer (EDUAC). The EDUAC used a binary code and had acoustic delay line memory.

The first commercially available computer was the Universal Automatic Computer (UNIVAC I), manufactured by Rennington-Rand (Sperry Rand) in 1951. Until this time, computers had been used by scientific or governmental agencies only. General Electric and Metropolitan Life Insurance were the first companies to use computers (the UNIVAC I) for business purposes. In the early 1950's UNIVAC and IBM were the major competitors in the computer market. UNIVAC announced their computers earlier but could not deliver as fast as IBM. Thus, IBM took the lead that it has maintained to the present.

Computers, starting with the Mark I, are often grouped in generations. The grouping may vary slightly depending upon the source of information but basic characteristics typify each generation. The computer from the Mark I to the ENIVAC are known as first generation computers. They can be characterized by their massive size, their use of vacuum tubes, and their use of machine language only.

In 1958-63 the second generation computers were developed. Transistors replaced vacuum tubes. Hence computers became smaller, faster and more dependable. Other computer languages became available, such as Formula Translator (FORTRAN) and Common Business Oriented Language (COBOL). Examples of second generation computers are IBM 1400's, 1600's, 7000's, UNIVAC 1107, and Burroughs 200's.

The third generation computers are those developed in 1964-70 such as IBM 360's, UNIVAC 9000's, and Burroughs 3000-8000 series. These computers use an integrate circuit that contain 100,000 components. Third generation computers were smaller, faster and more dependable than even second generation computers. More languages became available. In 1963, the computer language BASIC, Beginners All-Purpose Symbolic Instruction Code, was developed and purported to be easier than other languages. Computers also now had the capability of being used by more than one person at a time.

In 1970 the first microprocessor chip was developed, reducing an integrated circuit to a tiny chip and producing forth generation computers. Intel Corporation produced the first microprocessor, the 4004, used primarily commercially. They later produced the 8008, the 8080, the 8085, and others. Other companies offered competition such as the Z-80 from Zilag. These microprocessors opened the world of "home" or "personal" computing, although they were at first only available in "kit" form. In the mid-70's, Commodore Business Machines was the first company to produce an all-in-one personal computer, the Personal Electronics Transacter (PET). Not long after the PET came on the market, Radio Shack (Tandy Corporation) developed the TRS-80. The Apple was soon to follow. The Apple was developed by two young men, Steven Jobs and Stephen Wozniak, in California. After their first Apple sold immediately with orders for more, Jobs and Wozniak founded the Apple Corporation. Today, Apples are available through the Apple Corporation (white Apples) or through Bell and Howell (black Apples). Other microcomputers are also available, such as Atari, the Challenger (Ohio Scientific, Inc.) and the TI-99 (Texas Instruments).

Since the ENIAC, computers have steadily gotten smaller and cheaper--and often faster and more reliable. It is amazing to think that in less than forty years computers have gone from being the size of a house and weighing tons to being the size of a typewriter (actually the computer can be held in the palm of one's hand).

Surely, we've come a long way.

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SIGNIFICANT DEVELOPMENTS IN THE HISTORY OF THE DIGITAL COMPUTER

YEAR	INVENTOR	DESIGNATION	DESCRIPTION
300 B.C.		Abacus	Calculating device
30 B.C.	Greek	Digital machine	Device for astronomical calculations
1617	Napier	Napier's bones	Multiplication device
1642	Pascal	Calculating machine	First calculating machine
1801	Jacquard	Weaving looms	Control of looms using punched cards
1822	Babbage	Difference engine	Calculating tables by means of difference
1833	Babbage	Analytical engine	Design for a stored program digital computer
1890	Hollerith	Punched-card sorter	EAM equipment for processing census data

FIRST GENERATION

YEAR	INVENTOR	DESIGNATION	DESCRIPTION
1944	Aiken	Mark I	First general purpose computer
1946	Eckert, Mauchly	ENIAC	First use of electronic circuitry
1949	Wilkes	EDSAC	First electronic stored program computer
1952	Eckert, Mauchly, Von Neumann	EDVAC	First use of binary mode, acoustic delay line memory
1951-52	Remington-Rand	Univac I	First commercially available computer
1953	MIT	Whilwind I	First use of magnetic core memory

The first generation of computers came out in the late 1940's. These computers could perform thousands of calculations in one second. First generation computers were controlled by parts called vacuum tubes. They were hot and big. ENIAC was a giant computer of 18,800 vacuum tubes, weighed 30 tons and occupied 1,500 square feet of floor space. It was smaller and 1,000 times faster than it's predecessor, MARK I, developed in 1944. UNIVAC I contained 5,000 vacuum tubes and was considerably smaller and faster than its forerunners.

SECOND GENERATION

1958-63	NCR 330's, Honeywell 400's, RCA 301's, IBM 1400's, 1600's, 7000's, CDC 160's, Burroughs 200's, Univac 1107, GE 200's	Use of transistors in place of vacuum tubes

In 1960 the second generation computers were developed. These computers could perform work ten times faster than first generation computers. The reason for this extra speed was the use of a part called a transistor (a tiny amplifier) instead of vacuum tubes. Second generation computers were smaller, faster and more dependable than first generation computers.

THIRD GENERATION

1964-70	IBM 360's, Honeywell 200's, RCA Spectra 70, Univac 9000's, 1108, GE 600's, CDC 6600, 7600, 3000's, Burroughs 3000-8000 Series	Use of integrated circuits

Five years later, in 1965, the third generation computers were born. These computers can do a million calculations a second, which is 1,000 times as many as first generation computers. Third generation computers are controlled by tiny integrated circuits and are smaller than third generation computers.

FOURTH GENERATION

1971	Intel 4004, Motorola 6800, TRS-80, Pet, Apple, IBM 3030	Use of microelectronic chips

Fourth generation computers are now in use. The integrated circuits that are now being developed have been boiled down into a chip. This is known as microminiaturization, which means that circuits are much, much, much smaller than before. In other words, 1,000 tiny circuits now fit on one chip. Therefore, these computers are 50 times faster than third generation computers.

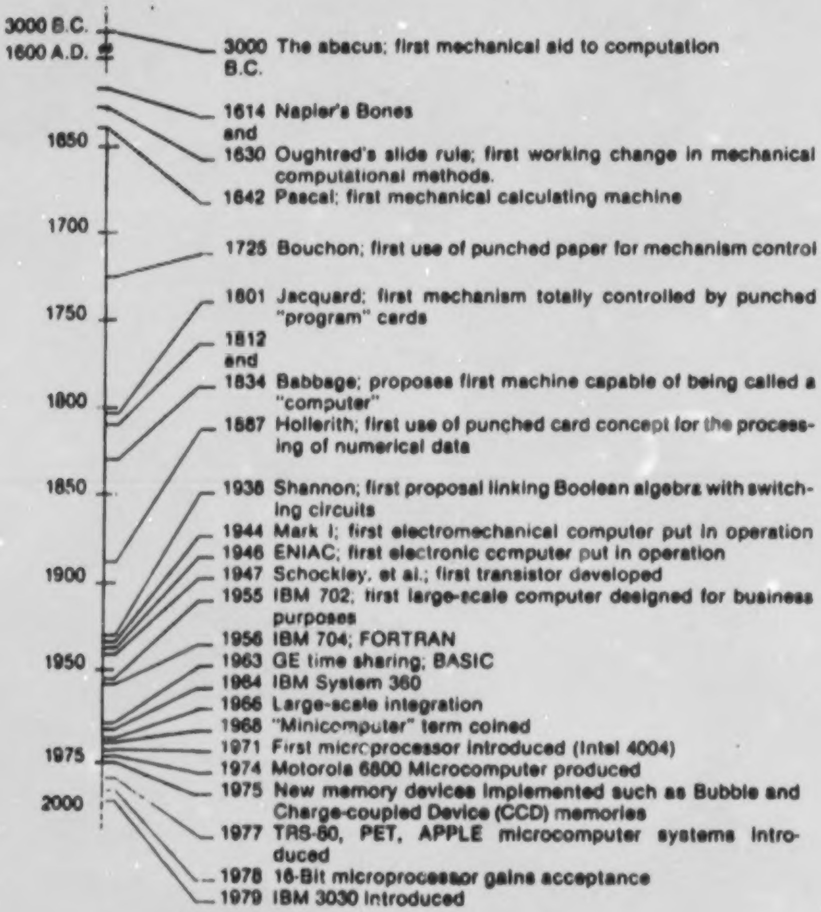
3000 B.C.
1600 A.D.
1650
1700
1750
1800
1850
1900
1950
1975
2000
3000 B.C. The abacus; first mechanical aid to computation
1614 and 1630 Napier's Bones
1630 Oughtred's slide rule; first working change in mechanical computational methods.
1642 Pascal; first mechanical calculating machine
1725 Bouchon; first use of punched paper for mechanism control
1801 Jacquard; first mechanism totally controlled by punched "program" cards
1812 and 1834 Babbage; proposes first machine capable of being called a "computer"
1887 Hollerith; first use of punched card concept for the processing of numerical data
1938 Shannon; first proposal linking Boolean algebra with switching circuits
1944 Mark I; first electromechanical computer put in operation
1946 ENIAC; first electronic computer put in operation
1947 Schockley, et al.; first transistor developed
1955 IBM 702; first large-scale computer designed for business purposes
1956 IBM 704; FORTRAN
1963 GE time sharing; BASIC
1964 IBM System 360
1966 Large-scale integration
1968 "Minicomputer" term coined
1971 First microprocessor introduced (Intel 4004)
1974 Motorola 6800 Microcomputer produced
1975 New memory devices implemented such as Bubble and Charge-coupled Device (CCD) memories
1977 TRS-80, PET, APPLE microcomputer systems introduced
1978 16-Bit microprocessor gains acceptance
1979 IBM 3030 introduced

Figure 1.7. A Schematic Representation of Some Important Events.

Glossary of Computer Terms

Alphanumeric - Alphabetic letters, numbers, and punctuation marks used in computer languages.

ASCII - American Standard Code for Information Exchange, a standard date transmission code.

Assembly Language - A program language that uses mnemonic codes for machine instructions.

BASIC - Acronym for Basic All-Purpose Symbolic Instruction Code, an English-like programming language developed at Dartmouth University. BASIC is the most common language for the micro-computer.

Band Rate - The transmission speed of the flow of data, usually in bits per second. Each character takes 11 bits, so 110 band rate is 10 characters per second.

BIT - Binary Digit. A bit represents one digit (1 or 0) in the binary number system.

Bus - The circuit(s) that connect the Central Processing Unit to the Input/Output devices.

Byte - A group of 8 bits handled as a unit. One byte is usually required to represent 1 alphanumeric character.

Chip - An integrated circuit etched onto a tiny piece of silicon or germanium.

CPU - Central Processing Unit containing the arithmetic and logic unit, control system and memory. It fetches, decodes and executes instructions and processes data.

CRT - Cathode Ray Tube, an electronic beam tube used for video displays in TV's and monitors.

DATA - Information a computer processes.

DOS - Acronym for Disk Operating System, the set of programs that operate a disk drive.

Hardware - The physical components of a computer.

IC - Acronym for integrated circuit, a chip that contains thousands of transistors, capacitors, and other electronic components.

Input/Output Devices - Any device that sends data or programs to, or receives them from, the CPU.

Interface - Any hardware/software system required to connect a computer to any other device.

Memory - The locations in a micro-computer (or other external device) that stores information and instructions. (See RAM and ROM)

MODEM - Acronym for modulator-demodulator, an instrument that lets a computer or terminal communicate with another computer over telephone lines.

Operating System - A program located in ROM that controls a computer's basic operations.

Peripherals - Devices that work with a computer, such as cassettes, printers, disks, modems, etc.

Port - A physical I/O connection that serves as an access to a microprocessor.

Program - A set of instructions that make a computer perform a given operation or process.

RAM - Random Access Memory which can be written to or read from and can be changed during operations. Its contents will be lost when the computer's power is turned off.

ROM - Read Only Memory is built into the computer and normally cannot be changed. The contents are not lost when power is turned off.

Simulation - Creating a mathematical model that reflects a life-like copy of a real action.

Software - The group of programs that instruct a computer.

INTRODUCTION TO BASIC

A Word About Communication

The computer and you communicate with each other through the terminal and the TV monitor. You can "speak to" the computer by entering commands through the typewriter keyboard. These also show up on the TV monitor. But the computer does not know that you are finished communicating a command until you push the RETURN key.

The computer communicates with you through the monitor and lets you know it is prepared to "listen" (receive more commands) by flashing a small square (the cursor) at the left side of the screen. When the cursor is not flashing, the computer is otherwise engaged and not to be disturbed.

The computer will follow commands directly after you push the RETURN key (direct execution) or will wait until you tell it to start (delayed execution). To accomplish delayed execution, you write your commands in a program -- a set of line statements preceded by numbers. When directed to do so, the computer will read these line statements in numerical order and carry out the commands within this program.

The computer speaks a very specialized language called BASIC. When it does not understand one of your commands, it will print on the monitor SYNTAX ERROR (or possibly some other error message). It means that you have not used BASIC properly. When the computer executes your program but fails to do what you wanted, remember -- it did what your commands directed.

When you and the computer are not communicating properly, it could be an occasion for negative thoughts and recriminations. But computerniks are positive people and refer to the process of unraveling communication difficulties as "debugging." Remember -- even the best of people have to "debug" occasionally.

Commands for Handling Programs

RUN - causes computer to execute whatever program is currently in its memory.

LOAD (e.g. LOAD PEOPLE) - transfers the program named PEOPLE from the storage disc or cassette to computer's memory.

RUN PEOPLE - loads and runs the program PEOPLE from storage disc or cassette in one step.

LIST - causes the computer to show on the monitor the individual steps of the loaded program; if the program is longer than the monitor screen, the program statements will scroll upward; push CTRL S (two keys) simultaneously to stop scrolling; push any key to continue.

SAVE (e.g. SAVE PEOPLE) - transfers a copy of the program PEOPLE to permanent storage (disc or cassette).

CATALOG - displays on monitor the names of the stored programs on the disc or cassette.

NEW - tells the computer to clear its memory and prepare for a new program (used only while writing programs).

Commands Used Within Programs

PRINT - causes computer to print any text in quotation marks that follows (e.g. PRINT "HOWDY!") or to print the result of a numerical computation (e.g. PRINT 18 + 4 will cause the monitor to display 22).

LET (LET X = 7) - assigns a value to the variable which follows.

READ and DATA - these two statements work together. The READ X statement causes the computer to assign to X the value it finds in the DATA statement (DATA 7).

REM - short for REMARK. Computers ignore whatever follows REM, permitting the program to explain to a human the purpose of nearby statements.

IF (   ) THEN (   ) - presents a condition to be met in the IF part of the statement before the action in the THEN part of the statement is to be carried out by the computer (e.g. IF X>0 THEN GOTO 250); when the condition in the IF section of the statement is not met, the computer ignores whatever follows in that statement.

GOTO (e.g. GOTO 250) - tells the computer to "go to" the statement with line number 250 and to continue running the program from there in normal line number order.

GOSUB and RETURN - (e.g. GOSUB 250) causes the computer to go to the statement with line number 250, to run the program in line order until it encounters a RETURN statement, and then to "return" to the next line statement following the one giving the GOSUB command.

INPUT - (e.g. INPUT "NAME"; N$) causes the computer program to stop and wait for the human to "put in" the information requested (to assign a value or string to a variable); in the example, the command prints NAME and pauses to wait for the human to enter his/her name which it assigns to the variable N$.

FOR and NEXT - (e.g. FOR Y = 1 TO 5 following by a later line statement NEXT Y) creates a loop situation in which the computer uses the variable Y as a counter for the number of times the program steps between the FOR and NEXT statements are to be repeated in order; the program assigns Y the value 1, continues to run in normal line order until it encounters the NEXT Y statement; and returns to the FOR Y = 1 TO 5 statement in which Y is now assigned 2; the action repeats five times and then the program continues at the next line statement following the NEXT Y command.

END - lets the computer know that the program is completed so that it can let you know (with the flashing cursor).

Some Functions Available Within the Computer

RND(X) - generates a random number between 0 and 1.

LEN(B$) - gives an integer equal to the number of characters in the string variable.

ABS(X) - gives absolute value of expression X.

INT(X) - gives largest integer less than or equal to argument X.

TAB(X) - spaces to the specified print column on the terminal.

SIN(X) - gives sine of expression X if X is in radians.

SQR(X) - gives square root of X.

ATN(X) - gives arctangent of X in radians.

COS(X) - gives cosine of X if X is in radians.

LOG(X) - gives natural (base e) log of X.

PI - constant value of pi, 3.1415927

Some Random How To's

Turn the computer on/off: the switch is on the back.

Correct a typing mistake: if "caught" before hitting return, backspace with the left arrow key (←) and type over the mistake; if the return key has been hit, just retype the line number of the program statement and the statement.

Remove a statement: retype the line number only of the statement and hit RETURN.

Clear the screen: type HOME and hit return or use the command CALL - 936 within a program.

Stop the computer on the run: hit the RESET key.

Recover from accidentally hitting RESET: type 3D0G and hit RETURN.

Put screen in graphics mode: type GR or HGR and hit RETURN.

Return screen to text mode: type TEXT and hit RETURN.

Put a space between lines on the screen: type PRINT and hit RETURN between the line commands.

Wipe out line currently typing: simultaneously hit the keys CTRL X and hit RETURN.

Use a variable to represent a string of words: follow the variable letter with $ and set equal to the string given in quotation marks (e.g. V$ = "VERY YUMMY")

Move to a horizontal screen location: use HTAB(X) in your program where X is the horizontal location or use TAB(S) in a PRINT statement (e.g. PRINT TAB(5)).

Move to a vertical screen location: use VTAB (X) in your program.

Continue typing on the same line on the monitor, but with a new command statement: use a semicolon at the end of the first command.

Place more than one command in the same program statement: separate by a colon.

Cause the computer to list output in 3 columns rather than 1 column: put a comma at the end of the command statement.

TAKE ONE STEP CLOSER TO YOUR COMPUTER

The following is a sometimes whimsical account of the trials and misfortunes of a first-time computer user. However, embedded in the tongue-in-cheek daily discoveries are truths and insights that other first-time as well as veteran users should appreciate.

D-Day *(when it all began)*

Watching and helping my friend unbox and hook together the computer, disk drive, integer card, super mod converter, and television set, I was struck by conflicting thoughts. "How on earth would I ever get it all packed together again, unpacked at my house, and back in operating order on my own?" But on the other hand, "How can this little equipment and material cost more than $2000 -- after all, that's one-third of a car sitting there!" *(shows you how long it's been since I've been in a showroom)*

Monday

After exhaustive study of two of six manuals that came with the computer *(no slouches on print, these Apple pushers)*, I discovered the main difference between Applesoft Basic and Floating Point Basic. Whichever command you choose automatically works for the other version of Basic and not what you have presently called up for the machine.

Tuesday

Learned something helpful today. The flashing light that moves across the screen as you type is the cursor. Until now, I had assumed the manual knew how I felt -- I had been following its directions to the letter.

Thursday

Showed kids how to turn computer on, load, and run a program today. I also told them they could play with the computer whenever I wasn't around. Wife fainted.

Saturday

The manual is proving useful. It described what was meant by SYNTAX ERROR. I was pleased to note that I had done nothing morally wrong, and I was especially glad that I didn't have to pay for it.

Sunday

Children showed me how to play "Little Brick Out" -- 5 bouncing balls to knock a wall of bricks down. I did respectably: Me - 16, Kids - 497. They asked why I bothered. *(I told them I just like to play fast.)*

Tuesday

Friend keeps explaining neat things the computer lets you do -- extolling the wonderful insights involved in playing such things as "Three-Mile Island." I politely inquire as to when I expect to be called upon to prevent a nuclear melt-down. *(Funny how long a short silence can become.)*

Wednesday

Watched with dismay as the computer accepted a dealer's disk and ran various diagnostic tests on itself. Monitor showed flashing RAM that was faulty. Somehow, that find didn't restore two weeks' loss of self-confidence experienced while I had assumed it was operator error at fault.

Saturday

Daughter picked two games from book of computer programs and typed into the computer. Three hours later, we got them to work, and I was eaten by my first "man-eating rabbit." Then I searched a 10 by 10 grid to no avail for "Hurkle." I think I might have found him/her/it if the program had produced graphics so I knew what a Hurkle looked like. It gets awfully boring responding to a screen full of questions. *(After awhile, you want to be found and torn apart by the Minotaur.)*

Week 3

Kids showed me how to use "Color Sketch" today and what BLOAD command meant. *(I think I understood it better the hour after we polished off the Thanksgiving turkey.)* It continues to amaze me how fast kids learn things informally and by reading and following directions. Somewhere in skim reading and assertive interaction, they failed to mention the advantages of reading it all the way through and doing it the way it was intended and explained.

Had opportunity to discuss starting up problems with fellow neophyte yesterday. Interesting how reassuring it was to find out I was not the only dumb person to sit before the keyboard. There seem to be lots of highly informed computerniks around except when you need them. And though they try to be patient when I ask my beginner level questions, I still get the impression I am asking them how to crawl while they are preparing for the hurdles. *(Not only can ignorance be shared -- it's also reassuring to find it in others.)*

Week 4

Started my first game of chess with a computer today. The computer is awfully slow in thinking -- the program says it is considering four possible moves ahead. I'm spending most of my time waiting on it, but I definetely have it on the run.

Next day

Lost my first game of computer chess. I offered my congratulations but skipped the concilatory handshake. At least, it hasn't told me what I did wrong. But when it smugly asked me if I wanted to play again, I pulled its plug *(smart aleck machine!)*

After an hour and half of effort today, I made the computer show some math functions in high resolution graphics and moved them around with some fair degree of alacrity. But I'm beginning to wonder when it can save me time and do problems I can't more quickly. So far, it's all one way -- all my mental resources and patience to make it do something I already know how to do faster. Also I wonder how the less well-trained mathematically can possibly fare in this area.

Week 5

Discovered today that the TV set will not display some colors in certain high resolution graphics programs *(it will put in horizontal but not vertical lines of the same color.)* I had been assuming operator mistake only to be vindicated again. The manuals tell us to experiment -- that the computer never makes a mistake. *(Obviously, that doesn't hold for manuals.)*

Had to set aside today definite hours in the schedule for serious computer work. Seventh grade daughter's desire to engage in more serious activities was hampered by glowering remonstrances from brothers to hurry up so they could play games. *(Solved the problem temporarily, but now when am I going to play "Brick Out"?)*

Week 6

Called friend to discover the size of the computer memory. I asked him what command to use to make the computer tell me how big it is. He told me to ask the human standing next to it. I sadly pointed out that I was that human. Turns out, you stare into its innards and count the RAMS *(not fuzzy creatures bearing wool)* inside the white square perimeter. Each RAM contains 2K of memory *(I'm beginning to talk like cereal commercials)*.

Got kids to sit down yesterday to explain FOR-NEXT loops to them. They asked if I had been in the apple cider bottle again. Later, they made the computer count backwards from 1000 by 5's. *(Insolent offspring! -- I had only made it count to 100 by 1's.)*

The time involvement required is making it increasingly clear that the average classroom teacher will not have the time *(even if expertise)* to program the computer to do meaningful and long-range or management-related activities.

Rather, they will be dependent upon the availability of supporting software and the funds to acquire the same. Limited use demonstrations and informal unsupervised learning seem to be the most viable uses of the computer for most users in the next few years without increasing the initial investment.

Week 7

Attended a meeting with fellow math educators to discuss microcomputers. Two advanced members of the group exchanged pleasantries and various nuances about machine language -- sounded like R2D2 talking to C3PO. Gradually, they returned to the real world and talked to we morons. *(Do I really want to spend 80% of my waking time speaking in acronyms and erector-set terms?)*

Programmed computer to work age-old problem about cows, sheep, and pigs Monday. The program ran well and I am increasing in proficiency to do more difficult things. Of course, I had solved that problem "by just thinking" when in grade school. I paused to reflect how growing kids will be changed by learning FOR-NEXT loops and GOSUB-RETURN subroutines that cause a computer to check 33,000 cases, rather than using the old bean to close in on the answer in a humanly manageable number of paper and pencil steps. Is the price of increasing computing power, mental laziness? *(Probably the same question, in new raiment, to that posed by Babylonian scholars contemplating the use of the abacus over stylus techniques.)*

Sometime
Later

Doctor diagnosed strange malady on right hand as INVADER's THUMB. He also mentioned that my eyes had little waving figures marching across them. His advice was to shut the computer down for 2-3 days and read a good book. *(After a short pause, I remembered what he was referring to.)*

And thus ends a brief glimpse at a continuing odyssey into the microchip age . . .

Educational Uses of Computers

Exploring the many educational uses of computers is valuable to understand the wide range of possibilities available with the technology. There are several different ways of organizing this discussion. The intent is to demonstrate the variety of uses, not to develop a partitioning or a taxonomy of uses. As a matter of fact, given a particular program, it may fit into several different categories. The headings are chosen only because they are descriptive.

In the following sections different uses will be described and sample programs of each type will be mentioned.

Computer Assisted Instruction (CAI)

In general, this is a wide range of educational programs which require student interaction with a computer in a learning situation.

1. Drill and practice

These programs are designed to provide practice for skills and knowledge learnings--that is, learning that is low in cognitive complexity. Following are some sample programs.

a. DARTS: practice in estimating the names of points on a rational number line (fractions).

b. UNCLE SAM'S JIGSAW: drill on identifying USA states by their shapes.

2. Tutorial

Programs classified as tutorial typically would be associated with learning objectives at higher cognitive levels than drill and practice objectives. In general, the goals of these programs are understandings.

a. Longevity: the human interacts with the program to determine the human's life expectancy and learn which factors effect it and how much.

b. Stereo: another interactive program designed to teach the student about the dangers of stereotyping people.

3. Simulations

Simulation programs are designed to provide the student with experiences that are too expensive, dangerous, complex, and time consuming to provide in a real world situation. Such programs provide models of phenomena in the real world for the student to study. Learning objectives are typically more cognitively complex than (1) drill and practice or (2) tutorial programs. These objectives are often at the analysis and synthesis levels.

a. Three Mile Island: The human acts as manager and operator of the Three Mile Island nuclear electrical generation facility to learn how electricity is generated at the plant. Not only does the human learn a schematic operation, but he or she has an opportunity to experience the frustration of dealing with the many different aspects of maintaining the facility.

b. Engine: Observe the operation of a four cycle internal combustion engine.

c. Lemonade: Run a lemonade stand in competition with others to learn some economic generalizations.

Computer Managed Instruction (CMI)

CMI differs from CAI in that CMI uses are designed to assist the teacher in the management of instruction. CAI programs are designed to teach students something.

4. Record Management

The purpose of record management programs are to store, analyze, and report on data. The analyses may be used for research studies but more often the systems are designed to help teachers with maintaining student progress reports and records. Some systems include features like computer generated report cards. Such reports can be updated on a weekly, or daily, basis to inform students and parents of student progress.

a. Millikin Arithmetic Programs: The set of programs provide drill in basic arithmetic in such areas as addition, subtraction, multiplication, division, fractions, and measurement. Each one is divided into more than 50 program levels by problem difficulty. Thus, the programs are easily classified as CAI. However, a management system is included to report to the students and the teachers about the students' programs. One option is a hard copy printout of students' progress. Also, teachers may make group or individual assignments.

5. Materials Generation

Computer programs can be easily developed to produce classroom materials for a teacher. Some of the printers currently available, like the Centronics 737, can produce ditto masters and overhead transparencies. These and other printers can produce clean masters which can be reproduced in classroom settings.

a. SIMEQ and FACTORS: These two teacher developed programs produce tests on "simultaneous linear equations" and on "Factoring Polynomials" respectively. The tests are properly formatted and include the answers. Thus, the teacher can reproduce the test with the answers, cover them, and reproduce the test without the answers. After the students have worked on the test, the teacher can pass out the copy with the correct answers.

b. WORDFIND: Sometimes teachers like to emphasize new vocabulary words in a unit of study. For example, an elementary science unit might include words like temperature, measurement, celsius, metric, gram, and liter. Wordfind puzzles, in which the student tries to find words hidden in an array of letters, provide an opportunity for students to identify the words in a game setting. The WORDFIND program generates the puzzle and a solution.

Other Uses

Aside from CAI and CMI, one can find several other educational uses of computers.

6. Educational Games

There are more games available on microcomputers than any other type of program. Some of these have educational value. Some have little or no such use! Be careful. Many of the games are intriguing and fun; however, if the purpose is simply playing, the use of classroom time is questionable. Some of the programs already mentioned could be classified as games, e.g., Darts, Three Mile Island, and Lemonade Stand. However, these programs appear to have some educational value.

Other games like Chess, Pirates, and Super Invaders may be a lot of fun but limited in educational value.

7. Programming

With the advent of the microcomputer and the associated availability of relatively inexpensive computers, more and more schools (and individuals) have purchased computers. This growth of computers has stimulated interest in computer programming. One of the major educational uses of computers is to teach students to program. In pre-college schools the language most often selected is BASIC which has been taught with success as low as the second grade (although we do not recommend teaching programming that early).

8. Problem Solving

Learning to program is easily associated with problem solving. To solve a problem using a computer, the individual would typically need to know to write programs. Usually in programming courses, students are asked to solve assigned problems. However, the two activities can be sufficiently different to list them separately in this paper.

An excellent set of problems for computer solution at the secondary school level was originally developed by Earl Orf and Diana Hestwood. These are available as card sets entitled Computer Conversations and More Computer Conversations from The Math Group, 5625 Girard Avenue, South, Minneapolis, MN 55419.

Computer Literacy Objectives-Cognitive

Hardware

1. Identify the five major components of a computer: input equipment, memory unit, control unit, arithmetic unit, output equipment.
2. Identify the basic operation of a computer system; input of data or information, processing of data or information, output of data or information.
3. Distinguish between hardware and software.
4. Identify how a person can access a computer: for example.
    1. via a keyboard terminal
        a. a site of computer
        b. at any distance via telephone lines
    2. via punched or marked cards
    3. via other magnetic media (tape, diskette)
5. Recognize the rapid growth of computer hardware since the 1940s.
6. Determine that the basic components function as an interconnected system under the control of a stored program developed by a person.
7. Compare computer processing and storage capabilities to the human brain, listing some general similarities and differences.

Programming and Algorithms

1. Recognize the definition of "algorithm."
2. Follow and give the correct output for a simple algorithm.
3. Given a simple algorithm, explain what it accomplishes (i.e., interpret and generalize.
4. Modify a simple algorithm to accomplish a new, but related task.
5. Detect logic errors in an algorithm.
6. Correct errors in an improperly functioning algorithm.
7. Develop an algorithm for solving a specific problem.
8. Develop an algorithm that can be used to solve a set of similar problems.

Software and Data Processing

1. Identify the fact that we communicate with computers through a binary code.
2. Identify the need for data to be organized if it is to be useful.
3. Identify the fact that information is data that has been given meaning.
4. Identify the fact that data is a coded mechanism for communication.
5. Identify the fact that communication is the transmission of information via coded messages.
6. Identify the fact that data processing involves the transformation of data by means of a set of predefined rules.
7. Recognize that a computer needs instructions to operate.
8. Recognize that a computer gets instructions from a program written in a programming language.
9. Recognize that a computer is capable of storing a program and data.
10. Recognize that computers process data by searching, sorting, deleting, updating, summarizing, moving and so on.
11. Select an appropriate attribute for ordering of data for a particular task.
12. Design an elementary data structure for a given application (that is, provide order for the data).
13. Design an elementary coding system for a given application.

Applications

1. Recognize specific uses of computers in some of the following fields:
    a. medicine
    b. law enforcement
    c. education
    d. engineering
    e. business
    f. transportation
    g. military defense systems
    h. weather prediction
    i. recreation
    j. government
    k. the library
    l. creative arts

2. Identify the fact that there are many programming languages suitable for a particular application for business or science.
3. Recognize that the following activities are among the major types of applications of the computer;
   a. information storage and retrieval
   b. simulation and modeling
   c. process control; decision-making
   d. computation
   e. data processing
4. Recognize that computers are generally good at information-processing tasks that benefit from the following:
   a. speed
   b. accuracy
   c. repetition
5. Recognize that some limiting considerations for using computers are as follows:
   a. cost
   b. software availability
   c. storage capacity
6. Recognize the basic features of a computerized information system.
7. Determine how computers can assist the consumer.
8. Determine how computers can assist in a decision-making process.
9. Assess the feasibility of potential applications.
10. Develop a new application.

Impact

1. Distinguish among the following careers:
   a. keypuncher/keyoperator
   b. computer operator
   c. computer programmer
   d. systems analyst
   e. computer scientists
2. Recognize that computers are used to commit a wide variety of serious crimes, especially stealing money and stealing information.
3. Recognize that identification codes (numbers) and passwords are a primary means for restricting the use of computer systems, computer programs, and data files.
4. Recognize that procedures for detecting computer-based crimes are not well developed.
5. Identify some advantages or disadvantages of a data base containing personal information on a large number of people (e.g., the list might include value for research and potential for privacy invasion).
6. Recognize several regulatory procedures; for example, privilege to one's own file and restrictions on the use of universal personal identifiers that help to insure the integrity of personal data files.
7. Recognize that most "privacy problems" are characteristic of large information files whether or not they are computerized.
8. Recognize that computerization both increases and decreases employment.
9. Recognize that computerization both personalizes and impersonalizes procedures in fields such as education.
10. Recognize that computerization can lead to both greater independence and dependence on one's tools.
11. Recognize that, whereas computers do not have the mental capacity that humans do, through techniques such as artificial intelligence, computers have been able to modify their own instruction set and do many of the information-processing tasks that humans do.
12. Recognize that alleged "computer mistakes" are usually mistakes made by people.
13. Plan a strategy for tracing and correcting a computer-related error, such as a billing error.

14. Explain how computers make public surveillance more feasible.
15. Recognize that even though a person does not go near a computer, he or she is affected indirectly because the society is different in many sectors as a consequence of computerization.
16. Exlain how computers can be used to effect the distribution and use of economic and political power.

Computer Literacy Objectives - Affective

1. Does not feel fear, anxiety, or intimidation from computer experiences.
2. Feels confident about his or her ability to use and control computers.
3. Values efficient information processing provided that it does not neglect accuracy, the protection of individual rights, and social needs.
4. Values computerization of routine tasks so long as it frees people to engage in other activities and is not done as an end in itself.
5. Values increased communication and availability of information made possible through computer use provided that it does not violate personal rights to privacy and accuracy of personal data.
6. Values economic benefits of computerization for a society.
7. Enjoys and desires work or play with computers, especially computer-assisted learning.
8. Describes past experiences with computers with positive-affective words, like fun, exciting, challenging, and so on.
9. Given an opportunity, spends some free time using a computer.

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*Proposed
One-Week Computer Literacy Course

Day 1: Historical Development of Computers

1. Objective - The student will be able to understand the historical development of computers.

2. Content Description - Suggested activities will develop an understanding and appreciation of
   a. the early counting devices,
   b. the four generations of computers - post-1940,
   c. the difference in analog and digital computers, and
   d. the people involved in the development.

3. Suggested Activities
   Teacher/students:
   a. discuss first use of and need for "computers": fingers, pebbles, etc.
   b. demonstrate use of manual and mechanical devices: abacus, slide rule, adding machine, etc.
   c. develop a historical time-line display of computing devices and computers
   d. compare the four generations of post - 1940 computers
   e. show any available films, filmstrips, or slides
   Students
   a. make a visual display(s) of people involved in computers: mobiles, posters, slides, etc.
   b. "print" a newspaper of articles on computers and their inventors
   c. make a card or board game on the history of computers
   d. collect examples or pictures of analog and digital "computers"

Day 2: Computer Applications in Society

1. Objective - The student will be able to understand the widespread applications and implications of computers to today's society.

2. Content Description - Suggested activities will develop an understanding and appreciation of
   a. the various uses of computers in all facets of society,
   b. the growth of computer applications in the last 40 years,
   c. the educational applications of computers, and
   d. the possible areas that computers may be used in the future.

3. Suggested Activities
   Teacher/Students:
   a. identify specific current and potential uses of computers in
      1. homes and recreation
      2. business and industry
      3. medicine
      4. law and law enforcement
      5. engineering
      6. transportation
      7. military defense
      8. weather predictions
      9. research and education
      10. libraries and information retrieval
   b. discuss other areas of computer applications

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*This outline is only a composite of several N.C. and out-of-state courses. It is provided as a resource only.

c. compare the number of areas of computer use in the decades since 1940
d. describe several computer applications in the local community
e. list several of the major types of computer applications - information storage and retrieval, simulation and modeling, process control, computation, data processing

Students:
a. clip articles from newspapers and magazines on computer applications for reporting and display
b. visit a local business or site that uses a computer - on-site or via terminal
c. collect information on why and when several local computer users implemented the computer into their work
d. collect computer - related or - printed information that is received by consumers
e. select one category of present or possible future computer use and "predict" what the computer application will be in 2001

Day 3: Impact of Computers on Society - Careers and Job Opportunities

1. Objective: The student will be able to recognize the careers directly related to computers and to understand the effect of the computers on job opportunities in general - past, present, and future.

2. Content Description - Suggested activities will develop an understanding and appreciation of
a. the vocations directly related to computers
b. the training necessary for different types of computing jobs,
c. the changes in, creation of, and elimination of various careers and occupations as a result of the use and improvement of computers,
d. the current employment opportunities requiring computer expertise,
e. the future implications of the effect of computers on certain vocations, and
f. the many programming languages suitable for particular applications and the training necessary.

3. Suggested Activities

Teacher/Students:
a. distinguish between various computer-related careers - key puncher/key operator, computer operator, computer programmer, systems analyst, systems manager,
b. discuss the training required for the various computer-related careers
c. make a list of job opportunities that have changed in some way due to computers since 1950
d. identify possible future employment that will be created, changed, or eliminated by computers
e. list the various programming languages, discuss their development, and the training necessary for mastery

Students:
a. clip newspaper and magazine want ads for computer-related jobs or ads specifying computer expertise in a job usually not associated directly with computers.
b. investigate the use of computers by guidance counselors and students
c. interview a person who uses a computer to discover what training he/she was required to have and what additional training would be advantageous
d. research magazine ads and college bulletins for the time period 1950-1980 to compare the increase in the references to computers
e. locate and show 1950 and 1960 films/filmstrips that predict what the "future" will be like as a result of technological advances
f. create a futuristic career involving a computer; describe the role of the computer

Day 4: Impact of Computers on Society - Limitations and Disadvantages

1. Objective: The student will be able to identify and understand the limitations of the computer for certain applications and the potential abuse and inconvenience of computers.

2. Content Description: Suggested activities will develop an understanding and appreciation of
   a. the limitations of computers for some applications,
   b. the limiting considerations (cost, storage, capacity, software availability) for using computers,
   c. the use of computers for criminal actions,
   d. the advantages and disadvantages of data bases, and
   e. the occurrance of "computer mistakes" - their origin, the effect on the recipient, and the possible procedure to correct them.

3. Suggested Activities

   Teacher/Students:
   a. discuss "jobs" that computers are currently incapable of performing and why
   b. list known misuses of computers - swindling, selling of mailing lists, invasion of privacy, unlawful use of equipment, etc.
   c. identify known data bases and their access procedures

   Students:
   a. report on an interview with a "victim" of a "computer error"
   b. interview a sampling of 10 people to determine their opinion on "Computers are responsible for dehumanizing governmental/business activities with citizens by assigning numbers to people."
   c. research and report on state and federal legislation to control computer crime

Day 5: Identification of the Computer Hardware and Its Function

1. Objective: The student will be able to recognize the components of a computer and to understand the function of each component.

2. Content Description: Suggested activities will develop an understanding and appreciation of
   a. the five parts of a computer - input, output, storage, control and arithmetic,
   b. the function of and the various devices for each of the five parts of a computer,
   c. the role each of the five parts plays in the problem-solving process,
   d. the advantages and disadvantages of different types of input and output materials, and
   e. the activities that computers can/cannot perform better than humans can.

3. Suggested Activities

   Teacher/Students:
   a. describe the five parts of a computer and their function
   b. display various types of the five parts - past and present
   c. identify the advantages and limitations of the various computer components discussed
   d. list the improvements in efficiency of operation of the computer components-historical time-line display

   Students:
   a. perform a problem-solving task as a computer would, then compare to the corresponding human action
   b. simulate the computer activities in calculating 2 + 5
   c. display different input, storage, and output media

RESOURCES ON COMPUTERS
August 1980

BOOKS:

BASIC - A UNIT FOR SECONDARY SCHOOLS, by Donald D. Spencer -- Ormond Beach: Camelot. 2nd Edition, 1980, 96pp, $3.95

Best we've seen yet to serve as a text on BASIC for student and teacher; buy a flowchart template and set about producing personal programs for leisure, instruction, or recordkeeping.

BASIC OMPUTER GAMES: Microcomputer Edition, ed., by David H. Ahl. New York: Workman Publishing, 1978. 8½ x 11 paperback, 183pp, $7.50.

Approximately one hundred program listings in BASIC language for use on microcomputers. Good for use as motivational devices, for studies in computer programming, or as models for your own instructional programs.

COMPUTER APPLICATIONS IN INSTRUCTION: A Teacher's Guide to Selection and Use, by Judith B. Edwards et al. New Hanover, New Hampshire: Time Share Corporation, 1978. 8½ x 11 paperback.

Intended for elementary and secondary teachers in all subject areas. Gives a practical guide for using computers in school, including hardware, programming languages, and different roles the computer can play in instruction. Contains chapters on Essentials of Hardware and Software, Instructional Uses, Selecting Computer-Based Instructional Units, and readings in various curriculum areas. Well-written, east to understand. Full of good examples. Extensive bibliographic references.

COMPUTER AWARENESS BOOK, by Donald D. Spencer - Ormond Beach: Camelot. 1978, $2.50.

First and 2nd grade introduction with adult help--a great deal of follow-up on terminology required: "flowchart", "program", "computer programmer", "BASIC"; probably most useful for bold black line illustration (suitable for coloring) after an introduction and actual use of a terminal.

COMPUTER DICTIONARY, by Donald D. Spencer - Ormond Beach: Camelot. 2nd Edition, 1979, 160pp, softbound $5.95, hardbound $9.95.

Whether for computer awareness or computer literacy, all media centers require a key to the computer lingo in the reference collection.

THE COMPUTER QUIZ BOOK, by Donald D. Spencer - Ormond Beach: Camelot. 1978, 128pp, $5.95.

After studying or teaching an introductory course in computer science or data processing, use these multiple choice questions and crossword puzzles to test yourself or your students; nine chapters cover from history of computing through applications and equipment to numbers systems, codes and occupations.

THE HOME COMPUTER BOOK, by Len Buckwalter. New York: Simon & Schuster, 1978. 5½ x 8½ paperback, 254pp, $4.95.

A very readable history of the development of the computer, leading up to the microcomputers on the market today. Simple explanations of micro hardware and how computers do what they do; things to consider when building or buying a microcomputer; general descriptions of applications at work and home. Sixty-eight pages of program listings in BASIC could provide good models for your own programs. Extensive glossary.

SCHOOL MEDIA SERVICES AND AUTOMATION: A survey and annotated bibliography of the professional iterature related to the automation of School Library Media Services, K-12, by Dan R. Twaddle, School Library Journal, Summer 1979, pp. 257-267.

A review of the literature from 1957 to July 1978; good examples of automation working for improved media services at the school level-computerized catalog, circulation systems, centralized processing or improved subject access; 67 item annotated bibliography.

THE STORY OF COMPUTERS, by Donald D. Spencer - Ormond Beach: Camelot. 2nd Edition, 1977, 64pp, $3.95.

Covers who's, what's, and how's of a subject feared by many adults; written for the 3rd grade up, it will be helpful for all who are timid about dealing with the technology which runs our lives every so insidiously; sometimes silly cartoons of varying styles do not distract and in general carry the intended information.

USING BASIC IN THE CLASSROOM, by Donald D. Spencer - Ormond Beach: Camelot. 1978, 224pp, $9.95.

Fortunately the title is misleading. It does a lot more than instruct in the use of BASIC, the computer language most appropriate for schools. Good talk on planning for the use of computers in the school whether time-sharing or micro-computers; discusses methods for teaching computer use; self-teaching, short course, integrated, computer science course, and extra curricular activity, provides overview on equipment components.

WHAT IS A COMPUTER? by Marion J. Ball. New York: Houghton-Mifflin, 1972, $2.85 paperback.

A beginner's book about computers. Child-like drawings and simple explanations of basic computer parts and their functions. Good for use with students (and with teachers who are pretending to look for information for their class). Excellent introduction to what computers are all about.

YOU JUST BOUGHT A PERSONAL WHAT?, by Thomas Dwyer and Margot Critchfield, Petersborough, N.H.: Byte Books, Subsidiary of McGraw-Hill, (no date) 8½ x 11 paperback, 343pp, $11.95.

An excellent resource for teaching beginners how to talk to their microcomputer. Oriented toward process rather than toward equipment. Assumes that reader has an entry-level understanding of what computers are and how they work. Full of exercises in programming which move from very simple to relatively complex patterns, building the reader's capabilities. Numerous programs in number games, word games, space games, home finance, and small business. Will train reader in good procedures for programming and in understanding the microcomputer's capabilities.

BE A COMPUTER LITERATE, by Marion Ball and Sylvia Charp. Morristown, New Jersey: Creative Computing Press 1977, 61pp, $3.95.

A basic introduction to computers for middle school and up.

ARE YOU COMPUTER LITERATE? by Karen Billings and David Moursand. Salem Oregon: The Math Learning Center, 1978, $6.95.

An informative exploration of the world of the computer. Chapter quizes and final exam are included.

MIRACEL CHIP: THE MICROELECTRONIC REVOLUTION, by Stanley L. Englebardt. New York: Lothrop, Lee and Shephard Books. 1979, 123pp, $6.95.

A fascinating account of how the microcomputer - the miracle chip - evolved, how it works, and how it can be used. Strengths of the book are in the readable description of involved electronic concepts and in the personalization of the advances in microelectronics. Good introductory book on computers for middle school and above.

COMPUTER PROGRAMMING BOOKS:

COMPUTERS AND MATHEMATICS, by James Poirot and David Groves, Manchaca, Texas: Sterling Swift 1979, 444pp., $21.95 with MICROCOMPUTER WORKBOOK - Apple II Edition and TRS-80 Edition, 1979, $4.95 with courseware (cassette $4.00, disk $50.00)

BASIC AND THE PERSONAL COMPUTER, by Thomas Dwyer and Margot Crutchfield, Reading, Mass.: Addison-Wesley, 1978, $12.95.

COMPUTER PROGRAMMING IN THE BASIC LANGUAGE, by Zeney P. Jacobs, et al, Boston, Mass.: Allyn and Bacon 1978, $9.00. Teacher's guide $3.00.

PERIODICALS FOR COMPUTER USE

Several periodicals for computer hobbyists. These do not use a highly technical approach, but do assume some understanding of microcomputers. To varying degrees, they contain articles about equipment, applications, procedures, reviews of books, hardware and software, listings of programs, and advertisements of computer-related products and services.

COMPUTE: The Journal of Progressive Computing.
Six issues per year; Single issue $2.00; 1 year $9.00. Circulation Department, P.O. Box 5406, Greensboro, NC 27403

COMPUTING TEACHER
Six issues per academic year; subscription only; 1 year $10.00. Subscriptions, Computing Center, Eastern Oregon State College, Le Grande, Oregon 97850

CREATIVE COMPUTING: The #1 Magazine of Computer Applications and Software. Twelve issues per year; Single issue $2.50; 1 year $15.00. Subscription Department, P. O. Box 789-M, Morristown, NJ 07960

80 MICROCOMPUTING: The Magazine for TRS-80 Users. Twelve issues per year; Single issue $2.00; 1 year $15.00. Subscription Department, P.O. Box 981, Farmingdale, NH 11737

INTERFACE AGE: Computing for Home and Business Applications. Twelve issues per year; Single issue $2.50; 1 year $18.00. Circulation Department, 16704 Marquardt Ave., Cerritos, CA 90701

ON COMPUTING: Guide to Personal Computing. Four issues per year; Single issue $2.50; 1 year $8.50. Subscription Department, P.O. Box 307, Martinsville, NJ 08836

PERSONAL COMPUTING - Twelve issues per year; Single issue $2.00; 1 year $14.00. Circulation Department, 1050 Commonwealth Avenue, Boston, Mass. 02215

PURSER'S MAGAZINE - Four issues per year; Single issue $4.00, 1 year $12.00. Robert Purser, P. O. Box 466, El Dorado, CA 95623 (good software directory)

+ TRS-80 APPLICATIONS SOURCEBOOK - Radio Shack: #26-2113, $.99 (listing of TRS-80 applications directory)

* AUDIO-VISUAL MATERIALS FROM CAMELOT PUBLISHING CO.

COMPUTERS FOR KIDS, by Donald Spencer. Designed for use in the elementary school classroom or as an introduction for anyone to the world of computers. Includes 2 books, sixty 35mm color slides, tape cassette, Teacher's Manual, and poster. No. 1039, $75.00

+ This is not a periodical
* These materials are in the process of being reviewed.

THE COMPUTER. A 40 slide/cassette presentation of secondary schools and above which introduces in an elementary way the basic concepts of computers and computer programming, including microcomputers and the BASIC language. No. 1101, $70.00

HISTORY OF COMPUTING. A 40 slide/cassette presentation on calculating machines and computers from prehistoric people to microcomputers. No. 1102, $70.00

COMPUTER USAGE/APPLICATIONS. A 40 slide/cassette program on computers in law, medicine, law enforcement, business, education, government, sports, etc. No. 1103, $70.00

INTRODUCTION TO COMPUTER SCIENCE. An 80-slide/cassette program for secondary and above. It includes the history, application and components of a computer (including micros) and discusses programming in BASIC. No. 1104, $120.00

Material provided by the Division of Educational Media and supplemented by the Division of Management Information Systems

Resources on Computers - Supplement
November 1980

Books

Computers and Education, by James L. Poirot. Manchaca, Texas: Sterling Swift. 1980, 89pp, $6.95. This text is designed to aid teachers and administrators in becoming familiar with the use of the computer in educational applications, both in instruction and administration.

Microcomputers and the 3 r's: A Guide for Teachers, by Christine Doerr. New Jersey: Hayden. 1979, 173pp., $7.95. This book is a suitable reference or a text to acquaint teachers with the wide range of computer and microcomputer applications at the secondary level.

Home Computers: A Simple and Informative Guide, by Scott Corbett. Boston: Atlantic Monthly Press, 1980, 115pp, $4.95 paper. An easy to read text on the microcomputer. Subjects discussed range from "Computers We Already Live With" to "Computer Language" to "Computer Crime and Abuse."

Computer Capers, by Thomas Whiteside. New York: Crowell. 1978, 164pp. This book surveys the new breed of ingenious thieves who exploit the flaws in computer systems and security, telling of creative schemes in an engaging style.

Microcomputer Systems and Apple BASIC, by James L. Poirot. Manchaca, Texas: Sterling Swift. 1980, 148pp, $8.95. This book contains general information on computer development, microcomputer system organization and flowcharting. The computer programming section, however, pertains to the Aple II microcomputer.

Computer Literacy Show and Tell Kit. Manchaca, Texas: Sterling Swift. 1980, $59.95. This kit consists of a ring binder containing nine computer components on skin-packed pages with explanatory text. The components are abacus, punched cards, magnetic tape, disks, transistor-resistor-capacitor, diode, circuit board, integrated circuit, and a stuffed circuit board.

Audio-Visual Materials

Modern Talking Picture Service
Call 704-392-0381 within 14 days of date desired. All 16mm films, free.
- Some Call It Software
- About Computers
- Thinking?? Machines (Southern Bell Film)

Booklets

Facts on Computer Careers - pamphlet. American Federation of Information Processing Societies, Inc., 210 Summit Avenue, Montvale, New Jersey 07645.

Computer Careers - booklet. Business Equipment Manufacturers Association, 1828 L Street, NW, Washington D.C. 20036.

Junior High School

COMPUTER
AWARENESS
PROGRAM

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1981

COMPUTER AWARENESS PROGRAM

I. Need

Computer awareness means "becoming aware of the extent to which computers influence our lives." Among other things, they record your birth and hospital records; schedule your classes in school and record your grades; calculate your salary, withhold your taxes, and print your paycheck; and they will probably bill your relatives for your funeral bill. Because of the advent of the readily available and cheap microcomputers, computers can now be used in the home for recreation and hobby, to maintain financial records, balance check books, and even control lights and appliances.

This is a program which will, in a three to five day period, attempt to help prepare the eighth grade students to live in a world in which computers affect almost every aspect of their lives.

The ultimate goal at the Junior High School should be a program in "computer literacy"--being able to take an idea and express it in such a way that the computer can carry out your intent. However, this can be achieved only by hands-on experiences and practice and will require more hardware and more time than is currently available.

II. Objectives

The students will learn:

1. The history of computers and computing devices.
2. The parts of a computer.
3. What computers can and cannot do and where they are found.

III. Outline

A. Lesson 1 - The History of Computers and Computing Devices (2 periods)

1. Show the filmstrip "History of Computing Devices." Have a discussion about why people need computing devices, what delayed the production of the high speed computer until the 1940's, and the differences between digital and analog computers.

2. Give each student a set of Napier Rods and show them how to work a computation problem with them. Discuss the advantages and limitations of these rods.

3. Have the students work simple addition problems on the abacus. Is this a digital or an analog device?

4. Have the student work problems on the "Pick" calculators. What type of device is this?

5. Give a classroom demonstration of how fast the "Apple II" microcomputer can work complicated problems.

Page Two

B. Lesson II - The Parts of a Computer (1 period)

1. Using the overhead and Bell Telphone's CARDIAC, show the steps a computer goes through in solving a problem and identify what each part of the computer does.

2. Show the filmstrip "Parts and Functions of Computers." Have students examine different types of input devices (tapes, cards, paper tapes, and keyboards). Discuss the different types of output devices.

3. Give a demonstration with the "Apple II" computer showing how a cassette tape recorder can be used as both a memory and an input device. Use the disk and explain how it works.

4. Open the cover on the "Apple II" and let the student see its inner works.

C. Lesson III - What computers can and cannot do and where they are found (2 periods)

1. Show the filmstrip "From Pebbles to Programs - Part 3." Discuss the ways a computer might be used in the home, by government, by business, by airlines, by banks, weather forecasters, or in the space program. Discuss things you would not expect a computer to be able to do.

2. Discuss the type of work, education needed, pay and job availability for these computer related jobs.

   a. Data Preparation Clerks
   b. Computer Equipment Operators
   c. Computer Programmers
   d. Systems Analyst
   e. Computer Service Technicians
   f. Mathematicians, Engineers, and Scientists
   g. Sales Representatives

3. Divide the students into three groups and have a group work at one of our two terminals or at the Apple II computer. Make sure that each student gets to spend some time at the keyboard interacting with the computer doing some math drill or simulations.

Page Three

IV. Evaluation

Part I

A. List three types of places where a computer is used.

1. ______________________________

2. ______________________________

3. ______________________________

B. List three ways you feel the computer will be able to help you in the future.

1. ______________________________

2. ______________________________

3. ______________________________

C. List three ways you think the computer will be used in the future.

1. ______________________________

2. ______________________________

3. ______________________________

Part II

A. Please match the answers in Column A to statement in Column B by placing the number of the answer in the space before the statement in Column B.

Column A

1. Hardware
2. Digital
3. On-line
4. Software
5. Chip
6. Vacuum Tubes
7. Printout
8. Time-sharing
9. Keypunch
10. Bugs
11. control
12. Terminal

Column B

____ A form of output from a computer which contains the information the computer has just processed.

____ When more than one person uses a computer at the same time.

____ A part which was used in first generation computers

____ Being hooked up to a computer over telephone lines.

____ A machine which punches holes in cards.

____ The computer program

____ Errors in a computer program

____ A computer that works by using numbers

____ The unit in a computer which directs the traffic

____ An input machine.

Page Four

B. Please circle the correct answer.

1. What is the set of instructions the computer uses?

   a. program
   b. memory
   c. statement

2. What machine, with a memory like a calculator, takes a problem, works on the problem and sends out the answer?

   a. chip
   b. computer
   c. transistor

3. Which part of the computer holds the information in storage?

   a. control
   b. memory
   c. arithmetic

4. Which type of input can hold the most information in the least amount of space?

   a. magnetic tape
   b. paper tape
   c. punched card

Part III

1. Read the statements below. When a statement is true about a computer, place a T before the statement.

   ____ a. Computers get tired.
   ____ b. Computers can think for themselves.
   ____ c. Computers are fast.
   ____ d. Computers usually make more mistakes over a long period of time than humans do.

2. Computers are used in schools, in the airlines and in stores. Choose one of these three places computers are used and tell how they are used.

   ____

   ____

   ____

3. Name something you could compare to a computer. Tell how it compares to a computer.

	INPUT	PROCESSING	OUTPUT
EX: CAR WASH	dirty car	washing the car	clean car

   ____

   ________________ ________________________________

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APPENDIX

1. Employers of Computer People

   a. Large businesses employee the most computer people.

   b. Next largest employer is the Federal Government (taxes, census, social security records, etc.).

   c. Manufacturers of computer equipment.

   d. Others - small businesses, schools, data processing firms, hospitals, etc.

JOB OUTLOOK FOR COMPUTER PROFESSIONS

Title	Description	Typical 1979 Salary	Demand in 1980 compared with 1970	Education needed
Data Preparation Clerk	Primarily Key-Punch operator.	$100-200 weekly	Down 25%	High School
Computer Equipment Operator	Inputs the programs and data. Makes sure the equipment is operating correctly.	$175-250 weekly	Up 80%	High School
Computer Programmer	Provides the computer with the instructions necessary to handle information being processed	$250-400 weekly	Up 42%	College degree required for many systems
System Analyst	Designs and manages computer systems	$200-600 weekly	Up 100%	Usually Master's Degree
Computer Technician	Repairs equipment	$200-400 weekly	Up 100%	2 years above High School

USERS AND USES OF COMPUTERS

1. Home
    - a. Recreation and hobby
    - b. Maintain financial records
    - c. Storage of records (recipes, telephone, etc.)

2. Business
    - a. Payroll
    - b. Word processing
    - c. Accounts payable
    - d. Accounts receivable
    - e. General ledger
    - f. Sales analysis
    - g. Investment return
    - h. Interest calculations
    - i. Depreciation calculation
    - j. Loan calculation
    - k. Inventory control
    - l. Financial reports
    - m. Mailing lists

3. Automatic control
    - a. Automobiles
    - b. Mixing chemicals
    - c. Robotics
    - d. Controlling milling machines (etc.)
    - e. Airplanes

4. Airlines and Hotels
    - a. Reservations

5. Banks
    - a. Process checks
    - b. Records

6. Weather Forecasters

7. Federal Government
    - a. Taxes and Social Security
    - b. Military
    - c. Space Program

Computer Books in the Junior High Library

1. Computers at Work, John Clark, Grosset and Dunlap.
2. The Electronic Brain, Joseph Cook, G.P. Putnams and Sons.
3. The Story of Computers, Charles T. Meadows, Harvey House, Inc.
4. Computers: Their History and How They Work, Richard Rusch, Simon & Schuster.
5. Computers, Fred Steinberg, Franklin Watts, Inc.
6. Computers! Alan Vorwald & Frank Clark, McGraw-Hill.
7. The Human Side of Computers, Daniel Cohen, McGraw-Hill.
8. The Robots are Here, D.S. Halacy, Jr., W.W. Norton & Co.

Sound Filmstrips Located in the Math Lab

1. Computer Series I: An Introduction to Computers, BFA Educational Media, Santa Monica, Calif.
   a. History of Computing Devices
   b. The Many Uses and Needs for Computers - Part I
   c. The Many Uses and Needs for Computers - Part II
   d. Computers today
   e. Computers and the World of the Future
2. Computer Series II: Introduction to Computer Programming, BFA Educational Media, Santa Monica, Calif.
   a. History of Digital Computers
   b. Uses of Digital Computers
   c. Parts and Functions of Digital Computers
   d. Flow Diagramming Introduction
   e. Introduction to Programming - Part I
   f. Introduction to Programming - Part II
3. Computer Series III: The Binary Number System, BFA Educational Media, Santa Monica, California.
   a. Binary Numbers - Part 1
   b. Binary Numbers - Part 2
   c. Binary Numbers at Work - Part 1
   d. Binary Numbers at Work - Part 2
4. Computers: From Pebbles to Programs, Math Matters.
   a. Part 1
   b. Part 2
   c. Part 3

Basic Language Programming Books Available in the Math Lab

1. A Guided Tour of Computer Programming in BASIC, Dwyer & Kaufman, Houghton Mifflin.
2. Camp (Computer Assisted Mathematics Program), First and Second Course, Hatfield & Johnson, Scott Foresman Co.
3. Communicating with the Computer, Jacobs, et.al, Allyn and Bacon, Inc.
4. My Computer Likes Me When I Speak in BASIC, Bob Albrecht, Dymax.
5. Computer Programming in the BASIC Language, Neal Golden, Harcourt, Brace, Jovanovich.
6. Using the BASIC Language, Thomas J. Miracle, Princeton Junior High School.
7. Programming the Apple II, Apple Computer, Inc.
8. Applesoft, Apple Computer, Inc.
9. Apple II Reference Manual, Apple Computer, Inc.
10. An Introduction to BASIC Language and the Microcomputer, Glenn & Baughman, Middletown School District.

Computer Magazines Available in the Math Lab

1. Personal Computing (monthly)
2. Creative Computing (bi-monthly)
3. Calculators & Computers

COMPUTER SCIENCE IN SECONDARY SCHOOLS: RECOMMENDATIONS FOR A ONE-YEAR COURSE

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Introduction

As computer use continues to grow in everyday applications, instruction about computers is also growing; one area where computer instruction is expanding rapidly is in the secondary school. A number of schools have recently begun, or are planning, courses in computer science.

Designing and implementing secondary level computer courses has been difficult because requirements for content and guidelines for establishing such courses have not been readily available to teachers and school personnel. If the experience of people who have set up computer science classes at this level could be gathered and made available to others planning such courses, establishing these courses would become simpler, with potentially better results.

Guidelines for Planning

The recommendations for curriculum content and the suggestions for implementing a computer science course that are presented in this report are intended to be guidelines. The status of teaching about and with computers is changing rapidly and the potential for new approaches, particularly through the concepts involved in personal computing, is tremendous. Nevertheless, it is imperative to address the current and near future situation. Doing so hopefully will prove helpful to teachers and school personnel who are planning computer science courses at the secondary level.

In addition to using this report, schools planning to begin computer science courses are urged to seek out other available resources. Potential resources are people who work with computers professionally, and people from computer science departments at nearby colleges and universities. These people can also be helpful in keeping a secondary school computer science course up to date. Because of the rapid pace of change in computer related fields, provision for periodic review of the course and the facilities should be established from the start. New equipment, new ideas and new procedures are continually appearing in this field and instruction should attempt to keep abreast of these changes.

The Focus

In defining goals and suggesting curriculum content for a computer science course at the secondary school level, it is necessary to focus on computer science as a part of overall computer education. Many different approaches to studying computers and computing are possible, and several of them fit into the secondary school context. Some of these are vocationally oriented. These are designed essentially to prepare the sutdent for employment in entry level positions. Training in data entry, computer operation and similar skills in business data processing are examples of this type of course, as are courses in machine repair and electronic technician fields.

Other computer courses that are appropriate at the secondary level are beginning steps in preparing the student for a professional career, such as computer engineering, computer programming or information sciences. These courses might be beginning courses from an undergraduate computer science program, moved intact to the secondary school. For these, advanced placement or college credit may be available. Such courses, however, are appropriate for only a small fraction of the secondary school population.

In contrast, the course described in this report is intended for the majority of students at the secondary level, and should be taught in all secondary schools, vocational or non-vocational. Like other introductory science courses at this level, it is designed to provide breadth rather than depth, exposing the student to a variety of facets of computing; its primary emphasis is on use of computers as tools to be applied in many different circumstances. Today's high school population contains some individuals who will be using computers in business, some in industry and government, or as tools in research, some for their personal use, and others in applications as yet unrecognized. Providing all these students with broad knowledge about computing in general will create a basis for them to build upon for their special applications of computers.

The above mentioned vocational and pre-professional course, plus advanced technical courses in computer languages, hardware and systems, will be available in specialized secondary schools and schools with extensive computer education programs. Every school, however, should provide an introductory computer science course, available to all the students in the school. A one-year course, designed as a self-contained unit rather than as a part of a sequence or as a group of modules about other courses, provides a highly effective vehicle for teaching the broadly based knowledge needed by most secondary school students.

Computer Science

The basic course in computer science should be designed to teach the student problem solving in the most general sense. In a computer science class, the student will use the computer as a means of learning problem solving skills. The techniques for problem solving learning in this context will be applicable by the student in many other environments, entirely separate from computing.

The students will also learn the ways computers are used in problem solving at several levels. For example, they will learn about computing tools for their own personal use, for small groups and organizations such as schools, for large organizations such as governments. The student will not be practicing solutions of problems using all these levels of application of computers. That is, they will not be acquiring the skills of programming as much as they will be learning about the ways computers are used as tools in many areas, so that they are aware of the broad spectrum of computer applications.

The course then should consist of applications-oriented, general interest topics, with emphasis on practical use of computers as a tool for problem solving, both by individuals and by society as a whole. The primary result should be computer literacy commensurate with the general education level of the student.

Goals

Thus the goals of a secondary school computer science course would be:

1. To provide the student with practice in making appropriate use of computers as tools for problem solving in a variety of circumstances, applying this both to individual and group problems.

2. To provide the student with a realistic concept of the power, usefulness and limitations of computers.

3. To provide the student with knowledge about the role of computers in current information processing and the effect on social structures of the application of computers.

4. To provide the student with a context from which to consider possible future directions in computing.

Programming

To accomplish these goals, the student would learn how to use a computer, including learning to program. Students should begin solving problems early in the course and programming tasks should continue throughout the course. Both in examples used in class and in problems solved by students, structured programming techniques should be used in development of the solution, from a prose statement of the problem, through levels of progressive refinement, until the actual code (the program) is produced.

Problems studied should range from simple, with program solutions involving only a few lines, to complex, with program solutions involving several subprograms. Some of these programs should be individually done and some should be group projects, yielding experience in team management. Students should be encouraged to present their own problems for solution and to seek out others in the school for whom they can do programming.

Study Topics

The following list contains a topics appropriate to a one-year course in computer science at the secondary school level. The ordering of and extent to which topics are to be covered will depend on the local implementation, and on the interests of the teacher and the students.

Problem solving, including	defining the problem breaking the problem into smaller subproblems until the solution is evident the concept of the algorithm graphic representation of the solution
Programming methods, including	structured programming techniques programming style documentation manual reading debugging
Programming language, including	details of a language syntax control structures functions and subroutines user interface (input/output) simple data structures simple sorting and searching simple file structures file manipulation
Computer environment, including	types of systems (batch, interactive, distributed) computer languages, including "natural languages" communications networks microelectronics hardware components and organization software, including library and user-written data storage (sequential and random access)

Areas of application, including	education research music, art and design entertainment government and law health business engineering libraries
Examples chosen from applications in	modeling and simulation information storage and retrieval artificial intelligence process control arithmetic calculations electronic funds transfer word processing personal computing
History of computing	from the abacus to modern computing people and events trends and predictions specific problems whose solution had special effect on the development of computing
Social and ethical implications	benefits to users economic effects privacy and security computer crime careers in computing futuristics

Some areas from which programming assignments might be chosen:

- Graphics
- Surveying
- School Activities
- Games
- Statistics
- Humanities
- Business
- Mathematics
- Navigation
- Social sciences
- Word processing
- Sciences

Prerequisites

Academic prerequisites for a computer science course at the secondary level are frequently either elementary algebra or geometry. These are not content prerequisites; while a very large part of computer science is mathematics, little mathematics is used in beginning levels. Rather, the experience with problem solving that one has in studying mathematics is useful for problem solving in computer science.

In all cases, provision should be made for the teacher to waive such prerequisites, as there are many students who are unsuccessful in standard mathematics programs but who may be very successful in the computer science course recommended in this report.

Languages

Programming should be in one language, and to some depth. The language available should be fairly simple, but powerful enough for meaningful programming, and should be widely used, rather than a hypothetical or specially created language. BASIC has enough capability for this course and is commonly available on most systems. Even though most students will only have access to one system and one language, they should be aware of other types of machines, of other systems, and other languages, including very high level languages as well as assembler and machine languages.

Programming Style

Throughout the instruction and practice in programming, good programming style should be emphasized. Even the simplest programs should be written in a manner that makes them easy to read and understand. Having students read and comment on each other's programs is one means of improving readability. Good documentation should be required as a regular part of all student programming. Efficient use of computer time and memory should be encouraged, but not at the price of human understanding and use of the program.

Facilities

This course will require the use of computer equipment. The requirements for facilities are flexible, but an interactive computer system is preferred. The system should have adequate storage available for student programs and files. Microcomputer systems of many kinds have sufficient capability for this role and are used in many schools. Hard copy capability is very helpful in the school setting, with many teachers feeling it essential.

Whatever the specific configuration of the system, there should be enough computer power available to provide each student with frequent hands-on experience and fast enough response time to keep the student from being discouraged and losing interest. An approximation of the needed facilities would require one terminal or microcomputer for each 15 to 20 students involved in computing. This would provide each student with about two hours per week usage. Serious consideration should be given to postponing the implementation of a computer science course if adequate facilities are not yet available in the school.

Access

Access to the machine should be easy and flexible. When possible, students should be able to use the computer outside of regular class or school hours. Optimally, all students, not just those currently enrolled in a computer science class, should have access to the computer.

When a computer system is planned for use in both school administration and instruction, special care must be taken to assure that students have sufficient access on an appropriate time schedule, and that administrative use does not interfere with instructional use.

Library Programs

An important consideration is that hands-on experience with a computer should start immediately at the beginning of the course. This implies that there will be a collection of library programs available for students to run as a preliminary to writing their own programs. Library programs need not be numerous, but should be carefully chosen; they should be well written and have good user interactions. In addition, these programs can provide working models for student programming and maintain high interest levels while the student is a novice.

Machine manuals, programming manuals and other external documentation should be readily available at the computer site. Other materials on computer use and applications, including books and magazines, should be accessible in the school library as supplements to the manuals.

Academic Credit

Typically, computer science has been initiated in secondary schools through the mathematics program, but it has also begun through science or business programs. Academic credit has usually been given as mathematics. Specific implementation of a new course will depend on local circumstances and administrative structures, with the course being taught through whichever department is best suited within the particular school. Computer science, however, is a separate discipline, and should be taught as such. The course should be integral, not mixed in with fragments of another topic or course. It should be listed in curriculum guides and on transcripts under a title that makes it clear that the course is computer science. Having a descriptive name on official documents is valuable both to the school and the student.

Teacher Preparation

It is expected that in the near future, formal requirements for computer science teachers will be widely established throughout the education system. Some schools and states already have established such requirements, and these should be met by teachers where the requirements exist. The report, "Teacher Education" by Taylor, Poirot and Powell (17) specifies a desirable set of guidelines for teacher competencies. They identify three sets of computing competencies: the first for all teachers regardless of their level or discipline, the second for teachers of computing as a subject, and the third for teachers who use computing in other subjects. In particular, teachers of the course described above should have the first and second competency sets.

Until more teacher training programs are available in computer science at the secondary level, however, many teachers will find themselves teaching computing because of a personal interest, but with little or no formal training. These teachers should be encouraged to continue their professional development in computing, but their enjoyment and enthusiasm should not be ignored as an asset in the instruction process. It is essential that a secondary level computer science course be taught in an exciting and interesting manner, with flexibility to allow for the creative process of programming and with recognition of the dynamic force that is modern computing.

Conclusion

This report specifies a number of recommendations for a one-year, secondary school computer science course, including possible course content, suggestions for facilities and resources, and ways of integrating the course into the existing school program. The main focus of this course is on problem solving with computing tools. Problem solving is an important skill for every person to learn. Computer science provides a means for secondary school students to learn problem solving techniques, while learning how people use computers as problem solving tools.

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COMPUTER ASSISTED LEARNING

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Background

The primary purpose of the study was to assess the current and projected use of the computer in U.S. public secondary/elementary schools, with special emphasis on the use of the computer in computer assisted learning. A part of this overall assessment was to determine factors impeding the use of computer assisted learning so that guidelines could be established to facilitate its use.

A sample of 974 school districts was selected to most closely approximate the total population of U.S. public school districts. The district superintendents were contacted through a personal letter and a 34 item questionnaire, in March, 1980. The letter encouraged superintendents to identify a person on their staff to complete the questionnaire and to serve as a future computer assisted learning coordinator. A portion of the questionnaire was devoted to a description of various computer assisted learning publications and programs which the districts could receive free of charge.

Summary

A total of 62.3% of the school districts completed and returned the questionnaires. Analyses of the data revealed the following:

1. In 1980, the percentage of school districts using the computer for instructional and/or administrative purposes stood at 90%. It is projected to rise to 94% by 1985.

2. Between 1970 and 1980, the best estimates of instructional usage of the computer showed increases from 13% in 1970 to 74% in 1980. Instructional usage is anticipated to reach 87% by the districts by 1985.

3. Computer assisted learning is currently in use in 54% of the districts, and represents the type of usage reported by the second largest number of districts.

4. Heaviest usage of computer assisted learning is in the nation's secondary schools. The mathematics departments show the largest usage, followed by the natural sciences, business and language arts.

5. Most computer assisted learning programs in use in the districts are written in BASIC, were acquired from outside the district, are predominantly drill and practice, and run on a variety of large, mini and microcomputers.

6. Secondary/elementary faculty and students give computer assisted learning a high rating.

7. Projections for 1980-85 indicate computer assisted learning will be used by more school districts than any other type of computer application. Usage is anticipated to rise from 54% of the districts to 74%.

8. Type of computer assisted learning usage is predicted to shift from the current emphasis on drill and practice to tutorials by 1975, and ultimately to simulations.

9. Microcomputers are anticipated to play an increasingly significant role in computer assisted learning usage in the school districts.

10. Computer assisted learning usage is projected to continue to be heavy in mathematics, natural sciences, business and language arts at the secondary level, while also expanding to more significant usage at other relevant high school fields such as social sciences. More extensive use is also anticipated at the elementary level.

11. Major impediments to implementation and successful use of computer assisted learning at the secondary/elementary level appear to be financial, lack of knowledge about computer assisted learning and computers, attitudes of faculty, and need for more and better computer assisted learning programs.

12. Major computer assisted learning task force activities felt to be helpful by the districts were identified as dissemination of information about computer assisted learning in general and about computer assisted learning funding sources, providing in-service training for faculty, and serving as a clearinghouse for existing computer assisted learning courseware.

Recommendations

In the light of the results of the current study and the authors' experiences, the following recommendations are offered:

1. School districts not now using computer assisted learning should appoint a coordinator to acquire relevant information and to assist in general with the implementation of pilot computer assisted learning projects.

2. School districts now using computer assisted learning should disseminate relevant informaton throughout the districts concerning the results of the use of computer assisted learning nationwide as well as the specific results of local projects. Training programs for faculty should be implemented. Liaisons with local higher education institutions and state departments of education should be formed to make use of faculty expertise as consultants and to develop joint funding proposals for submission to federal, state, and/or private agencies.

3. Major government agencies and private foundations should support information dissemination and consulting proposals to assist U.S. secondary/elementary schools to implement and successfully use computer assisted learning. In addition, these agencies should fund proposals to increase the quantity and quality of computer assisted learning programs.

4. The private sector, particularly computer vendors and publishing firms, should form cooperative agreements with secondary/elementary schools and institutions of higher education to help ensure that computer assisted learning programs developed in the future are of higher quality, and are disseminated widely at reasonable costs.

Contributors

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Reference

Chambers, J.A., and Bork, A. Computer assisted learning in U.S. secondary/elementary schools. New York: ACM, 1980.

Note: Limited copies of full report are available from Jack Chambers, Center for Information Processing, California State University, Fresno, CA 93740.

CURRICULUM

From "An Agenda for Action" (NCTM, 1980)

Recommendation 3--MATHEMATICS PROGRAMS MUST TAKE FULL ADVANTAGE OF THE POWER OF CALCULATORS AND COMPUTERS AT ALL GRADE LEVELS

3.1 All students should have access to calculators and increasingly to computers throughout their school mathematics program.

3.2 The use of electronic tools such as calculators and computers should be integrated into the core mathematics curriculum.

3.3 Curriculum materials that integrate and require the use of the calculator and computer in diverse and imaginative ways should be developed and made available.

3.4 A computer literacy course, familiarizing the student with the role and impact of the computer, should be a part of the general education of every student.

3.5 All mathematics teachers should acquire computer literacy either through preservice programs or through in-service programs funded by school districts in order to deal with the impact of computers on their own lives and to keep pace with the inevitable sophistication their students will achieve.

3.6 Secondary school computer courses should be designed to provide the necessary background for advanced work in computer science.

3.7 School administrators and teachers should initiate interaction with the home to achieve maximum benefit to the student from the coordinated home and school use of computers and calculators.

3.8 Educational users of electronic technology should demand a dual responsibility from manufacturers: the development of good software to promote the problem-solving abilities of the student and, eventually, the standardization and compatibility of hardware.

3.9 Provisions should be made by educational institutions and agencies to help in the necessary task of educating society's adults in computer literacy and programming.

3.10 Teachers of other school subjects in which mathematics is applied should make appropriate use of calculators and computers in their instructional programs.

3.11 Teacher education programs for all levels of mathematics should include computer literacy, experience with computer programming, and the study of ways to make the most effective use of computers and calculators in instruction.

3.12 Certification standards should include preparation in computer literacy and the instructional uses of calculators and computers.

Suggestions

a. Students must obtain a working knowledge of how to use computers.

*b. Curricula activities must be developed to use the capabilities of computers.

c. Discovery learning activities should be emphasized.

d. Problem solving activities should be the webbed techniques (unifying concept) for teaching mathematics via computers.

e. Emphasis should be placed on the teaching of mathematics with the computer and not on teaching about the computer with mathematics.

f. An introductory course (practice) in typing should be developed for students in the middle grades.

g. Course (software) should be examined (scrutinized) for:
   1. Instructional range
   2. Instructional grouping
   3. Execution time
   4. Program uses
   5. User Orientation: (I) Instructor; (II) Student
   6. Content
   7. Motivational aspects
   8. Instructional techniques

*From "A position statement of the NCTM"

Pedagogical Considerations

A. Instructional Computing vs. Computer Science

Definitions

1. Instructional Computing is any application of a computer in teaching and learning. The computer is thought of as a vehicle or tool to facilitate in the teaching/learning process.
2. Computer Science is the study of computers and their related languages. The computer is the main objective of instruction.

Instructional Computing is generally broken into the following areas:

a. Drill and Practice

b. Computing exercises for practice

c. Problem solving

d. Tutorial

e. Management of instruction

f. Information storage and retrival

g. Motivational aspects

a. Drill and Practice

1. Homework problems
2. Series of repetitive problems
3. Programs to keep records of competencies
4. Diagnosis of error paterns
5. Puzzles and patterns
6. Antimated game-like programs
7. Programs involving features such as immediate feed-back, varied praise and light reprimands
8. Diagnostic and prescriptive programs can be used that requires very little programing.

b. Computing exercises for practice

1. Place emphasis on tracing rather than flow-charting
2. Teachers will learn while teaching
3. Emphasize that programing is teaching a computer (It's I.Q. is extremely low.)

4. Programers (students) will learn while programing.
5. Emphasize that programing is a time-consuming endeavor
6. Allow students to complete programs
7. Allow students to correct (debug) programs
8. Allow students to modify programs
9. Allow students to experiment with programs
10. Allow students to write and run programs
11. Have students compare programs
12. Have students explain how programs work
13. Examples of computer exercises (and pedagogical hints)

*** Keep in Mind: The major purpose of computer exercises is to promote the learning of MATHEMATICS.

A. Use REM and Instruction Statements

```
10  READ A,B
20  PRINT A-B, 2*A+5, 3*BxB-2*A+4
30  DATA  5, 2, 7, 1, -2, 5
40  END
```

B. Determine the output. (Explain what is happening)

```
10  FOR N = 1 to 10
20  PRINT N, N/50, 10*(1/N)
30  NEXT N
40  END
```

C. Complete a program

```
10  PRINT "RADIUS", "CIRCUMFERENCE", "AREA"
20  READ R
30  IF R = 0, Then GOTO 80
40  PRINT R, _________, ________
50  PRINT
60  DATA 1, 3, 5, 7, 0
70  GOTO 20
80  END
```

D. Have student write and run programs

I. Write a program that will request the input of two fractions and then print out their sum and difference.

II. Write a program that will write the next 6 steps in a Fibonacci sequence from two numbers (1-12) input by the player.

III. MODIFY II to reverse the digits of the final term.

c. Problem Solving

1. Problem solving is not just solving problems. It's the study of situations and strategies.
2. Explore the uses of the computer in problem solving:
    A. Generating data and listing examples
    B. Organizing data
    C. Sorting, grouping and presenting data
    D. Draw a picture (figure)
    E. Present a simpler problem
    F. Restate the problem
    G. Simulate a situation
    H. Working backwards
    I. Educational (Instructional) Gaming

d. Tutorial

Programs through which the computer assumes total responsibility for instruction.

1. Usually involves some type of dialogue between computer and student
2. Diagnostic and prescriptive techniques are utilized
3. Results are analyzed and one of the following is usually persued:
    A. Remediation (skill reinforcement)
    B. Acceleration (next competency level)
    C. Enrichment
    D. Specific applications
4. Simulations will be used to illustrate teaching/learning behaviors

e. Management of instruction

Programs designed to:

1. Aid in time management
2. Equipment and material inventory
3. Keep track of instructional duties
4. Make course or homework assignments
5. Evaluate and analyze student progress
6. Generate criterion-referenced test with alternate forms
7. Individualize or randomize assignments (tests)

f. Information storage and retrival

Very little user interaction. Programs designed to:

1. Store, analyze and retrive information about
    A. Curriculum
    B. Students progress
    C. General data generation

g. Motivational aspects

1. Direct student interaction
2. Student control or placement levels
3. Gaming
4. Graphics
5. Color
6. Audio quantities

h.

i.

j.

State-of-the-Art Review of
Research and Projects on
Computers in Mathematics Education (K-12)

To summarize the state-of-the-art on the use of computers in mathematics education is a complicated task. As everyone is aware, there is a turmoil of activity. Reports of projects, conferences, software developments, research, hardware additions, and just plain interest in their potential or excitement about their capabilities appear from all over the country.

We know from the research of the past twenty years that computers can be used effectively in mathematics education in each of their various applications. We believe that much of this evidence transfers to microcomputers; thus far, however, few studies have appeared in which the microcomputer is used. Unlike the situation with hand-held calculators, where an emotional fear of their use was evidenced, microcomputers are generally accepted as a valid educational tool. The antagonism toward the use of calculators led to a plethora of studies to ascertain their effects and reassure parents and teachers that they would not harm achievement. The willing acceptance of microcomputers has not created this need for research evidence; consequently, efforts are focused far more on developing activities and materials for their use.

What follows is a collection of information to illustrate some aspects relating to the use of microcomputers. Examples of some of the research reports with microcomputers, summaries of some surveys on computer usage, and illustrative reports on a few projects are included. A reasoned analysis of the actual effect of microcomputers must take longer to evolve: we are still too close to the start of the outpouring of materials.

Contents	Pages	
		(no p. I.02)
Conclusions from several reviews	I.03 - I.04	
Results from PRISM	I.05 - I.07	(no p. I.08)
Results from NAEP	I.09 - I.10	
Research with microcomputers	I.11 - I.12	
Survey of Ohio schools	I.13 - I.21	(no p. I.22)
Survey of Arizona and other schools	I.23 - I.24	
Sources	I.25 - I.30	

Conclusions from Several Reviews of the Research on Computers in Mathematics Education

Can any kind of general conclusions be drawn from this body of research on computer applications in mathematics instruction? There is some support for such applications in all of the modes; this evidence is particularly strong in the areas of drill-and-practice and computer-augmented problem solving. (p. 25)

> Kieren, Thomas E. Research on Computers in Mathematics Education. Columbus, Ohio: ERIC Information Analysis Center for Science, Mathematics and Environmental Education, April 1973.

Suppes has reported extensively on the use of both tutorial and drill-and-practice programs [using computers]. He found that the drill-and-practice materials result in at least equivalent achievement in less time than it would take the classroom teacher using only conventional methods. The computer also readily collects data on how children are responding, thus facilitating diagnosis of their difficulties as well as increasing our knowledge of how they learn. (p. 5-8)

> Suydam, Marilyn N. and Weaver, J. Fred. Using Research: A Key to Elementary School Mathematics. Columbus, Ohio: ERIC Information Analysis Center for Science, Mathematics and Environmental Education, December 1975.

Despite the data-collecting potential of computers, little more is known from studies using tutorial computer-assisted instruction (CAI) programs with secondary school students than that students can learn from such materials. [They also can learn from non-tutorial uses of the computer.] (p. 58)

> Suydam, Marilyn N. A Review of Research on Secondary School Mathematics. Columbus, Ohio: ERIC Information Analysis Center for Science, Mathematics and Environmental Education, March 1972.

A little less than one third of the studies I have located were concerned either with technical variations in programs (e.g., rate or amount of feedback) or with the effects of CAI programs on non-cognitive student behavior, principally attitudes. The remaining studies [of 62] were split about evenly between those which were concerned only with student achievement in computation and those in which higher cognitive levels of student mathematical performance were involved.

In general, the findings in this general area have been positive, although the percentage of studies finding no significant differences has been larger among the studies involving higher cognitive level objectives than among those concerned only with computation.

CAI also seems to have no deleterious effects on student attitudes, although one study suggests that in primary school classrooms, heavy use of CAI may result in reduced interpersonal skills. (pp. 117-118)

Most of the experimental work [with computers as instructional aids] has been done with secondary school students, but a few used elementary school students. In some cases students had access to a computer and could use it in various ways, ranging from checking solutions to problems to exploring open-ended problem situations. In other cases students merely wrote programs or constructed flow charts without actually making use of a computer.

The results of these studies have not been spectacular. In almost every case [of 29 studies] of a significant difference, the students using a computer orientation performed better than the control students. However, about the same number of studies reported no significant differences. Nevertheless, this is clearly an area about which we need much more information, and a good deal more experimentation is called for. (p. 118)

Begle, E. G. Critical Variables in Mathematics Education. Washington: Mathematical Association of America and National Council of Teachers of Mathematics, 1979.

Priorities in School Mathematics: Executive Summary of the PRISM Project (edited by Marilyn N. Suydam). Reston, Virginia: National Council of Teachers of Mathematics, 1981.

The Priorities in School Mathematics Project (PRISM) was designed by the National Council of Teachers of Mathematics to collect information on current beliefs and reactions to possible mathematics curriculum changes during the 1980s. Knowledge of current beliefs can be useful in predicting which curriculum changes might be readily adopted and which ones might meet with resistance. Thus the data have a continuing usefulness as efforts are made to implement NCTM's *Agenda for Action* or seek other changes in the mathematics curriculum. (p. 3)

Major Points from the Preferences Survey: Use of Computers (pp. 18-19)

- Nearly 75% of the professional samples and 80% of the lay samples believed that the use of computers and other technology should be increased during the 1980s; 78% indicated that the emphasis on computer literacy should be increased. Further analysis indicates that the pattern for the two items is similar, with the largest percentages selecting the "somewhat more emphasis" option (see Figure 16). (This is characteristics of results on many items: people less often committed themselves to the extreme positions.)

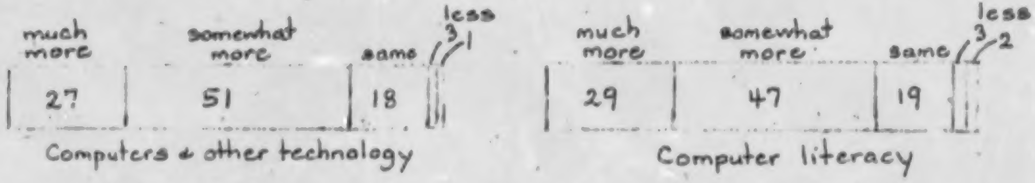


Figure 16. Percentages supporting increased emphasis on computers and on computer literacy.

- Instructional materials for computers that received moderately strong support included materials for individual projects (68%), workbooks with algorithms simulating computer processes (63%), detailed notes for teacher presentations (63%), and probability and statistics materials for use with computers (76%).

- Flowcharting and writing computer programs in BASIC were strongly supported (82% and 88%, respectively). However, other computer languages received much less support (31% and 57%).

- Almost no one (23%) believed that computer programming should be introduced in the elementary school, and very few in the professional samples believed that the ability to write programs should be a requirement for high school graduattion (see Figure 17).

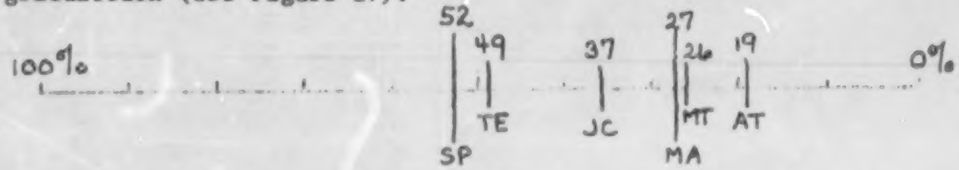


Figure 17. Percentages supporting the ability to write computer programs as a graduation requirement.

- Sixty-five percent of the lay samples supported the idea that at least one course in mathematics for the college-bound student should make extensive use of the computer.

- Teaching about the roles of computers in society was strongly supported (89%). Although less concern was noted for teaching about privacy and security issues, these still received moderately strong support (67%).

- Studying about the types of problems computers can solve received very strong support (91%), while the goal of introducing alternative techniques for solving problems was approved by only 70%.

- Requiring a computer literacy course of all students was given minimal support (53%) by the professional samples and essentially no support (34%) by the lay samples. However, lay samples did give moderately strong support (79%) to the integration of computer literacy topics within the existing K-12 mathematics curriculum.

- Respondents were divided about whether computer courses should be strictly elective, with 35% favoring and 40% opposing.

- Some support (58%) was given to requiring interaction with computers as early as the primary grades.

- The idea that knowledge of computers is only needed by specialists was strongly opposed by 89%.

- Having computers or computer access for students was given strong support (95%) at the secondary school level and moderately strong support (77%) at the elementary school level. Strong support (84%) was shown for having several small, personal computers for each class.

Major Points from the Priorities Survey

- Computer literacy was identified as the area that should receive highest priority among the five choices for the development of new materials in grades 7-12 (see Figure 25). Most of the respondents (58%) who ranked computer literacy first indicated it was because they thought the importance of the area would increase during the 1980s. (p. 23)

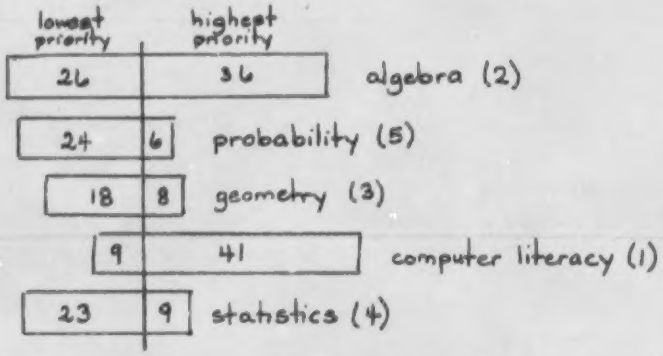


Figure 25. Percentages giving highest and lowest priority to five content areas for secondary school mathematics.

- A course that helps students understand how calculators and computers handle mathematics received second priority for being added to the curriculum. However, the SB [school board presidents] and PT [parent-teacher association presidents] samples gave far less support to this choice than the other groups. (p. 24)

- Respondents clearly indicated that more attention should be given to applications of mathematics and to computer literacy (in that order) than to unified or interdisciplinary approaches or to structure in mathematics. (p. 24)

- Orienting mathematics to careers or vocations and to consumers was given higher priority than orienting mathematics to computers, college preparatory work, or recreational purposes. (p. 25)

PRISM Data Related to NCTM Recommendations (p. 30)

> Recommendation 3: Mathematics programs must take full advantage of the power of calculators and computers at all grade levels.

- PRISM respondents indicated that they were well aware of the increasing emphasis that computers should receive in the mathematics curriculum. Surprisingly, lay samples gave even stronger support for increased emphasis on the use of computers than professional samples did.

- All groups queried indicated the desirability of having access to computers in mathematics classrooms at both elementary and secondary school levels. There was strong support for the development of new materials for computer literacy; all samples gave it high priority.

- Only half of the professional samples and less than half of the lay samples would require a computer literacy course for high school graduation. However, there was strong support by the professional samples for having all students receive some computer training before graduation, and the lay samples gave moderately strong support to the idea that at least one course in mathematics for college-bound students should make extensive use of the computer.

- Strong support was given to integrating computer literacy topics within the present curriculum.

- A course that helps students understand how calculators and computers handle mathematics was second in priority to a new course on consumer decisions.

- In a rank ordering of five areas for attention during the 1980s, computer literacy was second to applications. In a second rank ordering, computer orientation was third behind vocational and consumer orientations.

- Strong agreement was expressed by the professional samples for writing programs and for flowcharting, but only minimal support was given to writing programs as a requirement for high school graduation.

- Strongly supported for inclusion in the curriculum were the roles of computers in society, the types of problems computers can solve, and introducing alternative techniques for solving problems.

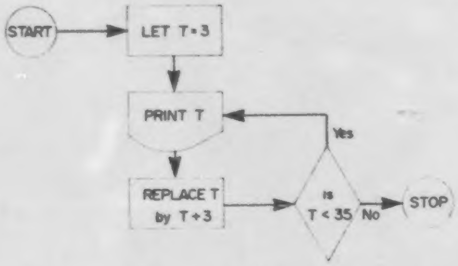
Results on Computer Literacy Items from NAEP

Carpenter, Thomas P.; Corbitt, Mary Kay; Kepner, Henry S., Jr.; Lindquist, Mary Montgomery; and Reys, Robert E. The Current Status of Computer Literacy: NAEP Results for Secondary Students. Mathematics Teacher 73: 669-673; December 1980.

In anticipation of future emphasis on computer literacy and in recognition of this as a topic in which performance should be monitored, the National Assessment of Educational Progress included exercises that dealt with several aspects of computer literacy in the 1977-78 mathematics assessment. The exercises included both cognitive and affective exercises, and were administered only to 13- and 17-year-olds. (p. 670)

TABLE 1
Flowcharting Exercise and Results

This is a flowchart.



What would be printed in the output?

	Percent Responding						
Age 13	5	11	10	7	11	9	47
Age 17	6	13	7	6	22	6	39
	○	○	○	○	●	○	○
	3	6	33	3 3 3 3 3 3 3 3 3 3 3	3 6 9 12 15 18 21 24 27 30 33	3 6 9 12 15 18 21 24 27 30 33 36 39 42 . . .	I don't know

The low levels of performance (about what would be expected by chance alone) and the high percentages of students who responded "I don't know" to these exercises suggest either that students have had little opportunity to develop knowledge about flow charts in general, or, more specifically, about flowcharts containing a loop. (p. 670)

TABLE 2
Programming Exercise and Results

This is a BASIC program.

```
 5  LET    T = 3
10  PRINT  T
15  LET    T = T + 3
20  IF     T < 35 THEN 10
25  END
```

What would be printed in the output?

	Percent Responding						
Age 13	5	3	8	8	14	9	54
Age 17	4	4	3	4	21	5	57
	○	○	○	○	●	○	○
	3	6	33	3 3 3 3 3 3 3 3 3 3 3	3 6 9 12 15 18 21 24 27 30 33	3 6 9 12 15 18 21 24 27 30 33 36 39 42 . . .	I don't know

Note that this programming exercise and the flow chart exercise presented in table I were designed to be parallel exercises. Practically the same percentage of 17-year-olds were correct on both exercises, but slightly more 13-year-olds were correct on the programming exercise than on the flowcharting exercise...

The high percentages of "I don't know" responses on the four cognitive exercises suggest that most students recognized their lack of knowledge about the subject of computers and chose not to even attempt the exercises. The results are substantiated by background data and are not surprising when only 14 and 12 percent of the 13- and 17-year-olds, respectively, indicated they had studied mathematics through computer instruction. Seventy-one and 62 percent of the 13- and 17-year-olds, respectively, thought that computers would be useful in teaching mathematics, although only 12 and 25 percent had access to computer terminals for learning mathematics in their schools.

... Only 8 and 13 percent of the 13- and 17-year-olds, respectively, said they knew how to program a computer ... (p. 671)

TABLE 4
Responses to Statements of Feelings about Computers

Statement	Age	Percent Responding Disagree	Undecided	Agree
a. Computers are suited for doing repetitive, monotonous tasks.	13	14	39	47
	17	11	64	25
b. Computers have a mind of their own.	13	56	14	30
	17	67	15	18
c. Computers dehumanize society by treating everyone as a number.	13	31	37	32
	17	31	28	41
d. The more computers are used, the less privacy a person will have.	13	42	22	35
	17	40	24	35
e. Someday most things will be run by computers.	13	10	15	76
	17	9	12	79

Research with Microcomputers in Mathematics Education

(DAI 41B:1955; Nov. 1980)

WHAT MAKES THINGS FUN TO LEARN? A STUDY OF INTRINSICALLY MOTIVATING COMPUTER GAMES

Order No. 8024707

MALONE, THOMAS WENDELL, PH.D. *Stanford University*, 1980. 93pp.

This dissertation is an examination of two questions: (1) Why are computer games so captivating? and (2) How can the features that make computer games captivating be used to make learning--especially learning with computers--interesting?

First, three studies are performed focusing on what makes computer games fun, not on what makes them educational. Then a rudimentary theory of intrinsically motivating instruction is developed, and a set of heuristics for designing instructional computer games is presented.

The first study is a survey of the computer game preferences of 65 elementary students. There are large individual differences in game preference, and the presence of a goal is found to be the most important feature in determining game preference.

The second and third studies involve testing multiple versions of specific games. The versions are isomorphic to each other except for certain key features such as fantasy, feedback, or scorekeeping. Differences in the appeal of the versions are then attributed to the features varied. The first game analyzed in this way is "Breakout," a computer game involving sensorimotor skill. The game is analyzed in terms of characteristics of the visual display, the motion of the simulated ball, and the score. The most important feature of the game is found to be the graphic display that simultaneously presents a score and multiple level goals. Versions with no obvious goal are significantly less appealing than the other versions.

The last study analyzes "Darts", a computer game designed to teach fraction concepts to elementary students. A significant individual difference is found--in this case based on sex. Boys like the fantasy of arrows popping balloons and dislike verbal constructive feedback, while girls appear to dislike the fantasy of arrows popping balloons and to like the music played in the game. Both fantasy and music appear to be more important in the appeal of the game than simple feedback.

The theory of intrinsically motivating instruction is organized in three categories: *challenge*, *fantasy*, and *curiosity*. Challenge is hypothesized to depend on goals with uncertain outcomes. Several ways of making outcomes uncertain are discussed, including *variable difficulty level*, *multiple level goals*, *hidden information*, and *randomness*. Fantasy is claimed to have both cognitive and emotional advantages in designing instructional environments. A distinction is made between *extrinsic fantasies* that depend only weakly on the skill used in a game and *intrinsic fantasies* that are intimately related to the use of the skill. Curiosity is separated into sensory and cognitive components and it is suggested that cognitive curiosity can be aroused by making learners believe their knowledge structures are *incomplete*, *inconsistent*, or *unparsimonious*. Relationships between this rudimentary theory and other theoretical frameworks such as mathematical game theory and information processing models of cognition are described.

INDIVIDUALIZING EDUCATION WITH MICROCOMPUTER PROGRAMMING

Order No. 8029098

ATHEY, MICHAEL KURT, PH.D. *University of Georgia*, 1980. 104pp.
Director: Ben O. Richmond

(DAI 41A:2504; Dec. 1980)

Presented is a "systems design" approach to providing an individualized educational program for all school-aged children. To this end, a modular family of computer programs called PIE (Programming for Individualized Education) has been developed. This software system operates on microcomputer equipment, providing comprehensive instructional and administrative aid which is affordable by virtually every school system. The PIE software system and its users manual are now separately available from the author and can be customized for LEA's unique implementation needs. The following describes need, rationale, design, operation, and tryout of the spring 1980 version of PIE as it appeared in the dissertation.

Chapter One contains a brief historical review of changing attitudes toward exceptional children. The progression from ancient treatment of the handicapped to very recent legislative action suggests that there is an increased social sentiment for education based on unique needs of each child. This culminates in recent legislation requiring action in addition to sentiment. This is used to develop the more general case supporting individual educational programs for all, based on each child's unique characteristics and needs.

Second, the rationale for specific design inclusions jointly rests on (a) current educational philosophy and (b) the capabilities of the microcomputer. It is suggested that design may be based on domains of objectives in general, without restrictions for type of domain or statement of the objectives themselves. The comprehensive design also allows for normative measurement outcomes to be included. Hardware considerations are then discussed.

Central to the design of the system are provisions for criterion referencing, PL 94-142 compliance, normative data management, individualized student file keeping, and automated file analysis for research and administrative reporting aid. The system's approach to these requirements is discussed at three levels in Chapter Three. First, a theory of operation is given, describing the manner that PIE was intended to operate. Second is a view of PIE from the end users' perspective, giving step by step instructions for use. Last is a molecular view, showing specific file organizational layout. Program listings are also separately available as Appendix D, in printed form or on diskette. PIE's expandability and ease of modification are discussed.

Chapter Four treats the implementation results and their implications for future work of this type. Many examples of output capabilities are offered and explained in a series of 9 of the thirteen figures. A quantitative approach to evaluating user concerns about such an innovation is described briefly. Results indicate that PIE was viewed as a useful innovation by teachers and the LEA project coordinator. The Mid East Regional Resource Center supported development of a technical paper to aid in the evaluation of this and similar software. The Maryland State Department of Education supported implementation of PIE for a reading domain, and has committed to more PIE installations using other curricula area objectives.

WHAT KIND OF MICROS? AND WHAT ARE THEY DOING IN SAN DIEGO? A survey of the 43 districts in San Diego County revealed that 28, or 65%, of the districts are using microcomputers for instructional purposes. A total of 455 computers was reported in use. The applications most frequently cited were drill and practice, instructional games, and computer programming. The information in this comprehensive report is especially valuable for schools and school districts embarking on an educational program using microcomputers. Teachers, supervisors, and administrators can get information on which microcomputers might work best in their own schools or school systems and for what instructional purposes the microcomputers would be most effective. A single copy of this comprehensive report is available to individuals. To obtain a copy or for more information, write to J. D. Gawronski, Director, Planning Research and Evaluation, Department of Education, San Diego County, 6401 Linda Vista Road, San Diego, CA 92111.

MORE MICROCOMPUTERS IN SCHOOLS

About one-half of the Nation's school districts use a total of 52,000 computers for instructional purposes, mostly "computer literacy." Microcomputers now outnumber timesharing terminals by 3 to 2.

Just over 7600 schools (one-half of all secondary schools, 14% of elementary schools and 19% of vocational and other schools) have computers.

Eighteen percent of the schools without computers plan to get one or more in the next three years. What about the other 82%? "No plans at present."

Source - U.S. Dept. of Education

Survey on Computers in Ohio Schools

The 37-item questionnaire on computer availability, uses, and needs was mailed to a randomly selected sample of 500 Ohio school buildings (K-12) in January 1981.* Returns from 355 schools were received, a (high) 71% return rate.

Responses to three demographic items provided information on the organizational level of the respondents' buildings, the range of building enrollments, and the kind of communities served. About one-third of the respondents came from buildings housing grades 9-12; slightly more than one-quarter were from those in buildings for grades K-6 (see Table 1).

Table 1

Type of Building Organization

K-6	26.5%
5-8	18.0
7-9	14.1
7-12	8.5
9-12	32.4
no response	0.6

Over 40% of the respondents were from buildings housing 301 to 600 students, with 25% from buildings enrolling 601 to 1000 students (see Table 2). Eighty-five percent were from schools of less than 1000 students; 60% were from schools of 600 or less. Not unexpectedly, smaller school enrollment was associated with elementary schools and larger enrollment with secondary schools. The smaller schools tended to be rural (47% of the rural schools were in the 0-300 range). Over 60% of the schools with more than 1500 students were suburban.

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* It was mailed by Steven P. Meiring, Ohio State Department of Education.

Table 2

Size of Building Enrollment

0-300	16.9%	K-6, 57%; 5-8, 20% rural, 47%
301-600	42.8	K-6, 37%; 5-8, 23% small city, 35%; rural, 28%; suburban, 26%
601-1000	25.1	9-12, 40% small city, 36%; suburban, 35%; rural, 21%
1000-1500	10.1	9-12, 81% suburban, 36%; small city, 33%; large city, 25%
over 1500	5.1	9-12, 100% suburban, 61%; large city, 22%

One-third of the returns were from small cities or towns, followed by those from suburban and rural communities (see Table 3). Only 11% were from large cities. In each type of community, more schools having 301 to 600 students were reported than other sizes.

Table 3

Type of Community

large city	10.7%	301-600, 34%
small city or town	32.7	301-600, 46%
suburban	28.2	301-600, 39%; 601-1000, 31%
rural	25.9	301-600, 47%; 0-300, 30%
nonpublic	2.5	301-600, 44%; 0-300, 33% [all either K-6 or 9-12]

Respondents were next asked to indicate the types of computer-related activities available in their building. Over 70% indicated that neither computer-assisted instruction (CAI), an instructional management system, programming courses, nor supplementary instruction within courses was available (see Table 4). Those in K-6 buildings selected this response even more than others did. Having one or more of these options available within the past two years was indicated by up to 18%, however; this is possibly a sign of recent interest in computer services. This percentage was highest in suburban and large city districts, with small city districts next. A number of others indicated that such services had been available for more than four years.

Table 4

Computer Services Available

Options	CAI	Management	Courses	Supplementary
not available	78.3%	71.0%	76.9%	70.4%
once available, now dropped	2.0	2.8	0.6	1.7
had less than 2 years	12.1	6.8	10.1	17.7
had 2-4 years	2.8	6.2	3.7	3.1
had more than 4 years	4.8	13.2	8.2	7.0
no response	0	0	0.6	0

What kinds of computer systems do respondents have for instructional purposes? While most indicated that none of the three options was available, 30% had microcomputers and 20% had interactive terminals hooked into a big computer (see Table 5). The percentage having each option increased as school size increased. Interactive terminals were available to 34% in large city schools and to 29% in suburban schools; batch processing was available to 26% in large city schools; and microcomputers were available to 44% in suburban schools, 32% in large cities, 25% in small cities, 20% in rural, and 22% in nonpublic schools.

Table 5

Kinds of Computer Systems Available

	Interactive	Batch	Microcomputers
available	19.7%	11.8%	29.6%
not available	79.7	87.6	69.9
no response	0.6	0.6	0.6

What kinds of microcomputers do schools have? As Table 6 indicates, Radio Shack computers were available most frequently. They were favored in schools with 301-600 or over 1000 students; 50% of the large city schools, 41% of the small city schools, and 37% of the suburban schools had them. The percentages ranged from 31% in grade 5-8 buildings to 63% in buildings with grades 7-12. The Apple computer was slightly favored in schools with 601-1000 students; 47% of the respondents in K-6 buildings and 38% of the respondents in 7-9 buildings indicated the Apple was available. The PET was also popular in elementary schools (K-6, 35%; 5-8, 50%); it was found in half of the schools sized 0-300 and comprised 44% of the computers in rural schools. Those indicating that more than one computer was available were most often in larger schools with more than 600 students or in nonpublic schools.

Table 6

Type of Microcomputer Available

type	% of total sample	% of those having computers
Apple	7.0%	22.1%
PET	7.3	23.0
Radio Shack	11.3	35.4
more than 1	2.5	8.0
other	3.7	11.5
no response	68.2	(no computer available)

When asked if they were reasonably satisfied with their present capability to provide computer-related instruction, only 24.5% responded "yes", while 69.9% responded "no" (5.7% did not answer). Those in large city schools (37%) and suburban schools (31%) were most satisfied, followed by those in small city schools (26%). Those in schools sized 1001-1500 were most evenly divided (43% yes, 54% no). By level, the percentages of response were: K-6, 39%; 9-12, 27%; 7-12, 23%; 5-8, 18%; 7-9, 13%.

What factors limit capability to provide computer-related instruction? Three-quarters saw money for hardware as a limiting factor, while only slightly over half indicated that the availability of appropriate software was a limitation (see Table 7). This concern for software was most evident in grades K-6 (78%) and 5-8 (71%); only 58% in 7-9 schools, 61% in 9-12 schools, and 48% in 7-12 schools had this concern. Training for instructional staff and staffing for an expanded curriculum were of concern to approximately 60%. Both of these concerns were greater in schools with over 1000 students, and lower in grades 7-12 schools and nonpublic schools. Only 21% considered administrative support a limiting factor. [It should be noted that 15 to 22 respondents answered these questions even though they were directed to skip them if they had indicated on the previous question that they were reasonably satisfied with their present capability.]

Table 7

Limitations to Providing Computer Instruction

	limiting	not limiting	no response
money for hardware	75.8%	5.9%	18.3%
training for staff	61.7	18.9	19.4
administrative support	20.6	59.2	20.3
staffing for expanded curriculum	62.3	17.5	20.3
appropriate software	52.1	27.6	20.3

What languages do staff members in the respondent's building know? Not surprisingly, BASIC was known by the highest percentage (34.1%); what is surprising is that this percentage is as small as it is (see Table 8). Respondents sometimes noted that a given teacher did not know more than one language. The percentage knowing BASIC was highest (50-70%) in schools with over 600 students; FORTRAN was cited most (39-47%) in schools with over 1000 students. BASIC was named by 75% of the nonpublic schools, and by 45% to 60% from grade 7-9 buildings up. The other languages were named most often by those in grade 9-12 buildings (not unexpectedly).

Table 8

Computer Languages Known by Staff

	BASIC	FORTRAN	COBOL	APL	PASCAL	other
yes	34.1%	16.9%	7.6%	3.4%	2.0%	4.2%
no	60.3	77.2	86.5	90.7	92.1	89.0
no response	5.6	5.9	5.9	5.9	5.9	6.8

BASIC was also the language most frequently taught to students (see Table 9). However, only 29% of the students in the Ohio schools surveyed were being taught BASIC; in fact, only one-third of the students were being taught any computer language. The percentages of those teaching BASIC were greatest in suburban schools (47%); it was taught in only 15% of the rural schools. Other languages were most likely to be offered in large city schools. Not unexpectedly, computer languages were taught more frequently as grade level increased, as Table 9a indicates. (Note that those reportedly teaching APL in grades K-6 and 5-8 may have mistaken the name.)

Table 9

Computer Languages Taught to Students

	BASIC	FORTRAN	COBOL	APL	PASCAL
yes	29.0%	4.2%	1.4%	1.1%	0.8%
no	65.9	90.7	93.5	93.8	94.1
no response	5.1	5.1	5.1	5.1	5.1

Table 9a

Computer Languages Taught to Students by School Level

	BASIC	FORTRAN	COBOL	APL	PASCAL
K-6	4.7%	0%	0%	2.3%	0%
5-8	20.7	1.8	1.8	3.6	1.8
7-9	33.3	0	0	0	0
7-12	30.0	3.3	0	0	0
9-12	54.4	11.4	3.5	0	1.8

When asked if their staff would be interested in attending a two-day conference on computers to be held in their geographic area, 74.4% said "yes" and 18.0% said "no" (7.6% did not respond). Interest increased by level, with 60% in grade K-6 buildings, 80% in grade 5-8 buildings, and 90% or more in other schools indicating "yes". Only 61% from small school (0-300 students) said "yes"; the percentages ranged from 79 to 94% in schools of other sizes.

The level for such conferences should be "introductory" for 47.6% and "intermediate" for 23.1%. Only 4.8% indicated "advanced". It is interesting that 24.5% gave no response. The introductory level was perceived as being needed most by those in schools with fewer than 1000 students; by rural and small city schools (70%) more than others (55%); and for grade K-6, 5-8, and 7-9 schools especially. The intermediate level was noted most by those in schools with 1000-1500 students, and especially by those in grade 9-12 schools.

The information to be included in the conferences were each considered appropriate by over 70% of the respondents (see Table 10). Information on hardware was less needed by those in schools with over 1500 students and by those in suburban schools. Both information on incorporating computers into existing courses and strategies for developing curriculum for computer courses were perceived as being less needed by those in grades K-6. Over 20% gave no response.

Interest in participating in a computer information exchange center was expressed by 70.4% (19.7% said "no" and 9.9% did not respond). The figure was slightly less (66%) for those in K-6 schools, with others ranging from 77% to 85%. Those in smaller schools (0-300) similarly expressed less interest (64%), while the range for schools with more than 300 students was 78% to 88%.

Table 10

Topics for Conferences

	yes	no	no response
Hardware and uses	71.3%	6.8%	22.0%
Software and uses	73.8	3.7	22.5
Programming courses	72.7	4.8	22.5
Incorporating into existing courses	73.5	3.9	22.5
Developing curriculum	71.0	6.8	22.3

When asked if they had locally-developed programs they would be willing to share with others through such a center, only 17.2% said "yes". While 9.6% did not respond, 73.2% said "no". The percentage with materials to share increased to 56% by those in schools with over 1500 students, and 35% by those in grade 9-12 buildings. Thirty-two percent of the suburban schools and 21% of the large city schools similarly had materials they would be willing to share.

Survey on Computers in Arizona Schools

In May 1980, a questionnaire was sent to the 226 school districts in Arizona by a group of educators at Arizona State University.[1] Responses were obtained from 46 districts, a (low) 20% return rate.

Slightly over half of the districts reported using computers, although two districts had especially high usage. The most frequent use of computers was in computer language courses in grades 7-12 (37% of the districts offered such courses), followed by basic skills in mathematics in grades 1-12 (26%).

Thirty-seven percent of the responding districts indicated they used microcomputers for instructional purposes, but 45% of all microcomputers were being used in one district. The numbers in use in May 1980 were:

Apple	8
PET	38
Texas Instruments	1
Atari	0
Radio Shack	22
other	9

Seventy percent indicated interest in exchanging information and software, while 65% each favored cooperative software development projects, teacher-training workshops, and evaluation of instruction.

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[1] Bitter, Gary G. Survey of Arizona Public School Practices and Needs for Computer Assisted Instruction. Computing Teacher 8: 31-34; No. 6, 1980-81.

Weiss, Iris R. Report of the 1977 National Survey of Science, Mathematics, and Social Studies Education. Final Report. Research Triangle Park, North Carolina: Research Triangle Institute, March 1977.

Mathematics teachers were asked about the availability and use of computers or computer terminals and hand-held calculators ... The majority of K-3 classes do not need these, according to their teachers; however 11 percent of K-3 mathematics classes would use computers if they were available and 15 percent need hand-held calculators but do not have them available.

The percent of mathematics classes using computers increases from 2 percent in grades K-3 to 5 percent in 4-6, 11 percent in 7-9, and 16 percent in 10-12.

A STUDY OF THE ADMINISTRATION OF INSTRUCTIONAL COMPUTER USAGE IN TEXAS PUBLIC SCHOOLS

Order No. 8000013

MONDY, Judy Bandy, Ed.D. East Texas State University, 1979. 202pp. Adviser: Stuart Chilton (DAI 40A: 3672; Jan. 1980)

Purpose of the Study: The purpose of this study was to determine the administration of instructional computer usage in Texas public schools during the 1978-79 school year. The study specifically examined usage and administrative resources, instructional uses, hardware and software, and budget.

Procedure: Questionnaires were mailed to the superintendent or data processing administrator in the 1,102 public school districts in Texas. A total of 969 questionnaires was completed and returned, and these questionnaires were divided into average daily attendance (ADA) groups for analysis. The four ADA groups consisted of Group 1 districts having an ADA of less than one thousand, Group 2 districts having an ADA of between one and five thousand, Group 3 districts having an ADA of between five and twenty-five thousand, and Group 4 districts containing an ADA of greater than twenty-five thousand. The questionnaire data were compiled and reported by frequencies and percentages.

Findings: The major findings of this study included the following:

1. Thirteen percent of the 969 reporting school districts cited instructional computing activities as follows: 4 percent of the districts in Group 1, 20 percent of the districts in Group 2, 54 percent of the districts in Group 3, and 87 percent of the districts in Group 4.

2. The majority of the districts involved between one and ten teachers and between one and two hundred students in instructional computing activities.

3. The employee most often cited as being responsible for administering the instructional computer program was a teacher, and the person to whom the responsible administrator reported was either the principal or the superintendent.

4. Most districts offered computer-related in-service education but had not developed an evaluation program for the instructional computer system.

5. Instructional computing was most often used in enrichment and remedial programs in computer-assisted instruction (CAI) and as a computational aid.

6. The computer was most frequently used in elementary schools in mathematics and reading. Secondary subject areas most often reported were mathematics and BASIC.

7. Regional Educational Service Centers (ESC's) were cited as the primary sources for in-service education, courseware, and hardware.

8. The reporting districts' budget allocations for instructional computing averaged between $52.42 and $69.83 per student served.

Conclusions: The major conclusions included the following:

1. Despite the small overall percentage of instructional computer usage, instructional computing appears to have impacted Texas public schools.

2. Instructional computer systems in Texas public schools did not seem to follow any discernible administrative pattern since no recursive profile emerged from the data.

3. The services offered by ESC's appeared to have furthered the growth of instructional computing in Texas public schools.

4. Inexpensive minicomputers and microcomputers appeared to have provided additional instructional computing capabilities to districts in each ADA group.

5. The sparsity of evaluation programs may indicate that instructional computing is still in an early stage of development in public education in Texas.

A DESCRIPTIVE ANALYSIS OF COMPUTER EDUCATION IN TEXAS SECONDARY SCHOOLS AND A PROPOSED COMPUTER SCIENCE PROGRAM

Order No. 8000793

MAYER, NautyByrd Patricia, Ph.D. North Texas State University, 1979. 170pp. (DAI 40A: 3935-6; [illegible])

The purposes of this study were (1) to identify and describe computer-related programs in secondary schools; (2) to identify and describe the perception of selected leaders in the field regarding the role of computer education in secondary schools in the future; (3) to utilize findings to recommend a program of computer-related education for secondary schools; and (4) to suggest the implications of this program.

Questionnaires were received from 186 (79 per cent) of the 234 principals from fifty-three districts in Texas which had previously indicated offering computer courses and from ninety-nine (73 per cent) of the 135 teachers listed for TEA and published in Guidelines for Computer Mathematics, 1977. Interview questions were sent to forty-two computer professionals. Answers to interview questions were recorded on cassette tape and returned by nineteen (45 per cent) professionals.

Some major findings of this study were that 66 per cent of the schools contacted offered one to three computer courses. The courses most frequently offered were problem solving, computer literacy, and programming. Computer courses have been offered for an average of six years in the responding schools. Sixty-one per cent of the courses were offered under the mathematics department but computer professionals stated a computer science department would be better. Five schools required courses containing computer-related material for graduation and eight schools used them as substitution for other courses. Teachers were primarily responsible for originating computer-related programs and for requesting new courses. Four teachers had computer science certification and nineteen had computer-related work experience. Computer professionals stated that the need for computer edu[illegible]tion in the secondary schools will increase in the future.

On the basis of information gained from the survey, the following conclusions were reached.

1. Few teachers had either a formal or professional education in the computer field.

2. Although computer-related courses were not found to be offered through a computer science department computer professionals said this would be the best administrative arrangement.

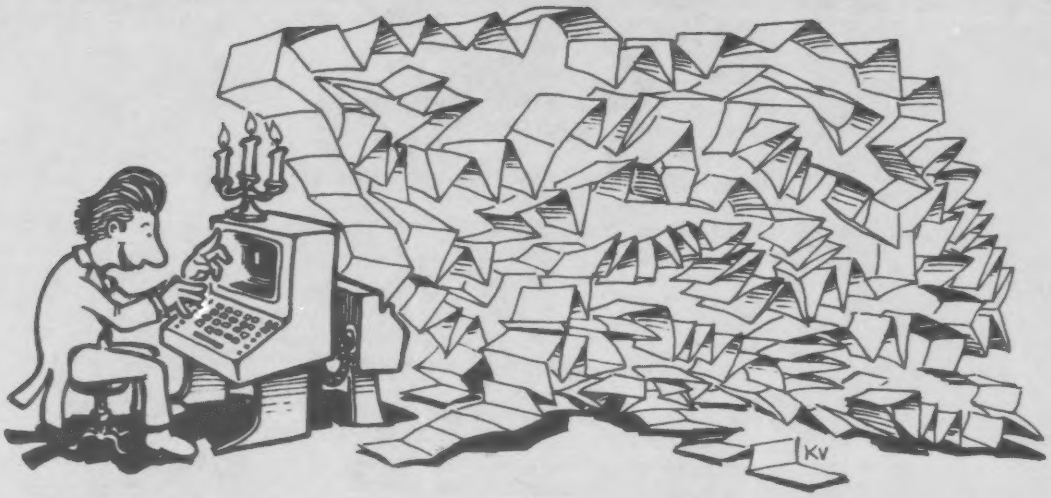
3. Findings show that 18 per cent of the schools taught computer operations and 24 per cent taught keypunch. However, selected leaders said that keypunch and computer operations are not important subjects for high school students.

4. Few schools require computer-related courses for graduation or recommend substituting computer courses for other courses. From this, it follows that requirement or substitution will not be common in the near future.

5. The following computer-related courses were suggested as ones that might be taught in secondary schools: Computer Literacy, Computer Programming, and Computer Structures.

Recommendations are that an extensive study be made on the interface between high school computer courses and introductory computer courses in colleges and universities and that a study be made comparing the use of large computers and microprocessors in the classroom.

PAGES 87-89 "ANOTHER LOOK AT EDUCATIONAL SOFTWARE AND BOOKS" DELETED DUE TO COPYRIGHT RESTRICTIONS.



Micro Computers Make Light Work of Managing Instruction

Individualizing instruction for a classroom of 30 children--or a multi-aged group of 80 to 100--can generate a mountain of paperwork. In fact, one of the principal restraints on making the most of individualized and objective-based curricular programs is the difficulty in filing, sorting, and then using test scores and other achievement information to organize instructional groups and produce progress reports.

Using a computer to manage that part of instruction is one answer to the paperwork problem, but the cost of such systems is often prohibitive, particularly for small school districts. Typical annual cost for one school doing management on a time-sharing computer ranges between $13,000 and $25,000 according to Don McIsaac, professor of educational administration at the University of Wisconsin.

But McIsaac's computer research project at the R&D Center has come up with a tool that makes the management of the paperwork mountain as easy as the management of a molehill, and at a low cost. The tool is an information storage and retrieval system that--like most elements of the computer revolution rolling through the nation's schools--is based on micro-computers. Those computers are compact in size, low in price, and easy to use.

The system developed by McIsaac's team is called Micro CMI (Computer Managed Instruction) and operates on computers inexpensive enough for schools to purchase and operate in one building. The Micro CMI program can maintain records of 800 students and can handle 37 separate curricular areas. It works with any objective-based program in elementary or secondary schools.

One of the system's most valuable uses is identifying students with similar learning needs. For example, let's look at Ms. Jones' second grade math class where she is preparing to teach a topic

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on subtraction. The topic has 10 objectives, each of which requires previous mastery of other objectives.

Instead of taking the whole class through the objectives in the same sequence, Jones will use Micro CMI to determine which children have mastered prerequisites for which objectives and then group them accordingly into several clusters.

She requests a grouping recommendation from Micro CMI. After a search of its memory to determine who has mastered the prerequisites for the various objectives, the micro computer prints its suggestions. Based on her classroom observations, Jones makes some changes in the suggested groups and then proceeds with the instruction. The computer keeps track of who's in the final groups and of each student's progress.

Besides storing information about individual student achievement on specific learning objectives and identifying groups of children with similar learning needs, the system can provide reports for diagnosing and prescribing learning activities, produce group performance information, and generate student progress reports for parents. Micro CMI can also produce the data needed to complete reports of Individualized Education Plans (IEP's) in special education programs.

McIsaac estimates that one school's annual cost for Micro CMI including all expenses except personnel time would run between $3 and $4 thousand. The Danville, Illinois, school district has cut even those costs substantially by using one micro-computer to manage the objective-based reading program in all of its 13 elementary schools. A Wisconsin school district where the system has been field-tested uses Micro CMI to successfully and inexpensively manage reading, math, science, and physical education instruction and is preparing to apply it to social studies.

The Micro CMI system is available for the cost of reproducing software. For details, contact either John Wende or Don McIsaac at the R&D Center (608/263-4333).

Micro-computers are suddenly of such interest in education that there's now a clearinghouse for information about their school applications. Write: MicroSIFT, Computer Technology Program, Northwest Regional Educational Laboratory, 710 SW Second Ave., Portland, Oregon 97204.

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Title:	Intellectual Growth and Understanding Mathematics
Author:	Kenneth Lovell
Pages:	25
Date:	February 1971
Form:	Offset, with cover
Price:	$0.85
Description:	Presents assumptions based on Piaget's theory of cognitive development, reviews recent research on pupils' understanding of mathematical ideas, and discusses implications for teaching.

201M	ED 049 934
Title:	Teaching Mathematics to Disadvantaged Pupils: A Summary of Research
Author:	Marilyn N. Suydam
Pages:	68
Date:	April 1971
Form:	Offset, with cover
Price:	$1.80
Description:	Summarizes the findings of research on the teaching of mathematics to the disadvantaged. Includes an annotated list of research divided into two major areas, educationally disadvantaged and academically disadvantaged.

202M	ED 049 079
Title:	Research in Elementary School Mathematics - 1970: Annotated List of Research References
Author:	Marilyn N. Suydam
Pages:	50
Date:	April 1971
Form:	Offset, with cover
Price:	$1.50
Description:	Lists research related to mathematics teaching and learning at the elementary school level which was published during 1970. Categorized by references or research summaries, articles or reports published in journals, and dissertation abstracts; each reference is annotated.

203M	ED 053 980
Title:	Teaching Resources for Low-Achieving Mathematics Classes
Authors:	Kenneth J. Travers and Others
Pages:	66
Date:	July 1971
Form:	Offset, with cover
Price:	$1.80
Description:	Reviews teaching approaches and general resource materials for low achievers in both elementary and secondary mathematics classes. Includes two bibliographies of resource materials and references.

204M	ED 059 900
Title:	A Review of Research on Behavioral Objectives and Learning Hierarchies
Authors:	Henry H. Walbesser and Theodore A. Eisenberg
Pages:	82
Date:	January 1972
Form:	Offset, with cover
Price:	$1.80
Description:	Summarizes research on behavioral objectives and learning hierarchies and tabulates results into supporting and non-supporting categories. Although the majority of the studies refer to mathematics and science, other subject areas are included.

206M ED 064 126
Title: Research on Mathematics Education (K-12) Reported in 19[illegible]
Authors: Marilyn N. Suydam and J. Fred Weaver
Pages: 87
Date: March 1972
Form: Offset, with cover
Price: $1.80
Description: Annotated listing of research reported in 1971 in United States journals and in Dissertation Abstracts International.

207M ED 064 156
Title: Issues in Mathematics Education
Author: James F. Gray
Pages: 31
Date: April 1972
Form: Offset, with cover
Price: $1.80
Description: The keynote address for the Forum on Teacher Education at the NCTM Annual Meeting, 1972. Discusses broad issues and problems of both mathematics education and mathematics teacher education.

208M ED 059 917
Title: Promising Practices in Mathematics Teacher Education
Author: Jon L. Higgins, Editor
Pages: 210
Date: April 1972
Form: Offset, with cover
Price: $3.90
Description: A compilation of 64 papers from the Forum on Teacher Education, National Council of Teachers of Mathematics Annual Meeting, 1972. Contains descriptions of innovative programs; two-thirds pertain to elementary school teacher education, the remainder to secondary school teacher education.

209M
Title: Papers from the Forum on Mathematics Teacher Education
Author: Jon L. Higgins, Editor
Pages: 39
Date: April 1972
Form: Offset, with cover
Price: $6.80
Description: A collection of papers prepared for discussion at the Forum on Teacher Education at the NCTM Annual Meeting, 1972. Topics include: issues and problems in mathematics teacher preparation, guidelines and standards for teacher education, course content recommendations, and proposed guidelines for teacher preparation.

210M ED 068 329
Title: Meaningful Instruction in Mathematics Education
Authors: J. Fred Weaver and Marilyn N. Suydam
Pages: 73
Date: June 1972
Form: Offset, with cover
Price: $1.80
Description: This monograph focuses on discussion of the influence of meaning theory on elementary school mathematics programs and instruction. Includes a review of research on the importance of meaning and the effect of teaching with meaning. Includes an extensive list of references.

211M ED 068 340
Title: Language Factors in Learning Mathematics
Author: Lewis R. Aiken, Jr.
Pages: 47
Date: October 1972
Form: Offset, with cover
Price: $1.50
Description: Discusses the relationship of verbal factors to mathematics achievement and reviews research from 1930 to the present. Considers the effects of verbalization in the mathematics learning process, mathematics functioning as a language, readability of mathematics materials, verbal ability and problem solving, and other factors. Includes an extensive bibliography.

212M ED 077 731
Title: Use of Computers in Mathematics Education Resource Series: Computer Innovations in Education
Author: Andrew R. Molnar
Pages: 87
Date: February 1973
Form: Offset, with cover
Price: $2.35
Description: Includes discussion of the impact of the computer on society, types of computer systems and languages, instructional applications, administrative uses, libraries and data bases, the design of computer-oriented curricula, and cost effectiveness.

213M ED 077 732
Title: Use of Computers in Mathematics Education Resource Series: Computer-Extended Problem Solving and Enquiry
Author: Larry L. Hatfield
Pages: 39
Date: February 1973
Form: Offset, with cover
Price: $1.50
Description: Reviews some of the pedagogical rationales and research evidence related to use of computers as a problem-solving tool in mathematics classes. Includes discussion of philosophies and objectives, effects of computer programming on mathematics achievement, motivation and attitudes, and influence on problem-solving ability.

214M ED 077 733
Title: Use of Computers in Mathematics Education Resource Series: Computer Bibliography for Mathematics Education
Author: Marilyn N. Suydam, Editor
Pages: 100
Date: February 1973
Form: Offset, with cover
Price: $2.35
Description: Annotated listing of selected books, articles, and other documents on computers. Organized by: the general educational role of computers; computer languages and programming; and mathematics instruction applications, including teaching about computers, general uses in mathematics classes, tutorial and practice modes, and problem-solving mode.

215M ED 077 734
Title: Use of Computers in Mathematics Education Resource Series: Research on Computers in Mathematics Education
Author: Thomas E. Kieren
Pages: 43
Date: April 1973
Form: Offset, with cover
Price: $1.50
Description: Reviews research on a wide variety of computer applications in the mathematical classroom -- computer-based instruction, especially drill-and-practice and tutorial modes; computer-managed instruction; and computer-augmented problem solving. Includes analytical comments on the findings and status of research.

216M ED 076 437
Title: Research on Mathematics Education (K-12) Reported in 1972
Authors: Marilyn N. Suydam and J. Fred Weaver
Pages: 80
Date: April 1973
Form: Offset, with cover
Price: $1.80
Description: Annotated listing of research reported in 1972 in United States journals and in Dissertation Abstracts International.

217M ED 077 730
Title: Ability and Creativity in Mathematics
Author: Lewis R. Aiken, Jr.
Pages: 50
Date: April 1973
Form: Offset, with cover
Price: $1.80
Description: The relationships of intelligence, achievement, age, sex, heredity, and psychosocial factors to mathematical creativity are carefully reviewed and discussed.

218M ED 077 773
Title: Recent Research in Cognition Applied to Mathematics Learning
Author: M. C. Wittrock
Pages: 37
Date: April 1973
Form: Offset, with cover
Price: $1.80
Description: Discusses recent research on cognition and its implications for mathematics education. Learning as a generative process, structural organization, processing of information, processes and structures, individual differences, brain research, higher-order processes, motivation, and delay-retention effects are discussed.

219M ED 036 670
Title: Research Reporting Sections of the National Council of Teachers of Mathematics 48th Annual Meeting (1970)
Author: Jon L. Higgins, Editor
Pages: 69
Date: March 1970
Form: Offset, with cover
Price: $1.80
Description: Contains abstracts of research reported at the NCTM meeting. Includes reports on conservation, student evaluation of teachers, the relationship between personality and achievement, teacher characteristics, problem solving, geometry, logic, and probability.

222M ED 076 387
Title: Research Reporting Sections of the National Council of Teachers of Mathematics 51st Annual Meeting (1973)
Author: Jon L. Higgins, Editor
Pages: 109
Date: April 1973
Form: Offset, with cover
Price: $2.35
Description: Contains 20 abstracts of research reported at the NCTM meeting. Includes reports on structural factors, logical reasoning, problem solving, teacher education, evaluation, geometry, and other topics.

223M ED 086 518
Title: Unpublished Instruments for Evaluation in Mathematics Education
Author: Marilyn N. Suydam
ages: 260+
ate: January 1974
Form: Offset, with cover, perfect bound
Price: $3.55
Description: Provides annotated information regarding unpublished tests related to mathematics education. Information includes title, developer, content, format, sample, reliability, correlations, validity, and references.

224M ED 086 517
Title: Evaluation in the Mathematics Classroom: From What and Why to How and Where
Author: Marilyn N. Suydam
Pages: 70
Date: January 1974
Form: Offset, with cover, perfect bound
Price: $2.35
Description: Provides many helpful suggestions for the classroom teacher regarding how to evaluate and how to improve classroom evaluation. An extensive annotated list of references provides sources of tests, item blanks, and research on evaluation techniques as well as references on evaluation in mathematics.

225M ED 091 239
Title: Research on Mathematics Education (K-12) Reported in 1973
Authors: Marilyn N. Suydam and J. F. Weaver
Pages: 83
Date: 1974
Form: Offset, with cover, perfect bound
Price: $2.75
Description: This annotated bibliography lists research related to mathematics teaching and learning which was published in the United States during 1973. The listing covers the levels from kindergarten through grade 12, and is divided into three major sections. The first section lists research summaries which review groups of research studies. The second section contains research reports which appeared in journals during 1973. The final section includes dissertations announced in Dissertation Abstracts International.

226M ED 091 250
Title: A Survey of Doctoral Programs in Mathematics Education
Authors: Jerry A. McIntosh and F. Joe Crosswhite
Pages: 48
Date: 1973
Form: Offset, with cover
Price: $1.50
Description: This paper is a survey and description of current doctoral programs in mathematics education in the United States. To gather the data a questionnaire sufficiently flexible and comprehensive to tolerate a variety of programs was developed. The questionnaire was sent to the Dean of the College (School) of Education, Dean of the Graduate Schools, and Chairman of the Department of Mathematics in each of the 200 institutions sampled. The data collected and reported include the following categories: institutional data, professional faculty, description of doctoral programs, financial assistance for doctoral candidates, placement of recent graduates and research, development, and dissemination activities. Although listings of doctoral programs in mathematics education have been made previously, this survey is the first systematic attempt to gather descriptions of doctoral programs on a broad basis.

227M ED 089 986
Title: Mathematics Education Abstracts and Index to Research in Education, 1966-1972.
Authors: Jon L. Higgins, Compiler, and Others
Pages: 335
Date: 1974
Form: Printed, perfect bound
Price: $18.00
Description: Contains abstracts to nearly all materials related to mathematics education (research reports, instructional materials, teachers guides, etc.) included in Research in Education (RIE) for the years 1966-72. Subject and author indexes are provided to facilitate searching. This is the best tool for a manual search of ERIC's RIE and a quick way to scan materials contained in Research in Education related to mathematics education.

228M ED 097 225
Title: A Categorized Listing of Research on Mathematics Education (K-12) 1964-1973
Author: Marilyn N. Suydam
Pages: 364
Date: August 1974
Form: Offset, perfect bound
Price: $6.90
Description: Provides a listing of research reported in journals published in the United States, in Dissertation Abstracts and Dissertation Abstracts International, and in Research in Education for the years specified.

229M ED 102 030
Title: Instructional Strategies: A Preliminary Taxonomy
Authors: M. David Merrill and Norman D. Wood
Pages: 92
Date: November 1974
Form: Offset, perfect bound
Price: $2.35
Description: The focus on the paper is apparent: strategies for instruction. The authors propose a taxonomic vocabulary with which instructional strategies can be described. They suggest a taxonomic organization for relating the variables involved in instruction, and symbols for representing these variables and their relationships. The premise is that, through the application of such a taxonomy to research on instruction, the development of a theory-based approach to instruction will be facilitated. There is much detail in the descriptions and many illustrations to clarify specific points.

230M ED 100 893
Title: Cognitive Psychology and the Mathematics Laboratory
Author: Richard Lesh, Editor
Pages: 149
Date: 1974
Form: Offset, perfect bound
Price: $3.55
Description: Presents articles regarding the relationship between mathematics laboratories and cognitive psychology. Issues and problems include: applications of mathematical ideas, concrete embodiments of mathematical ideas, computer assisted laboratory activities, clinical diagnosis of student errors, teacher training (using laboratory techniques), and directions for future research.

231M ED 102 021
Title: Mathematics Laboratories: Implementation, Research and Evaluation
Authors: William M. Fitzgerald and Jon L. Higgins, Editors
Pages: 81
Date: November 1974
Form: Offset, perfect bound
Price: $2.35
Description: Publication based on three papers related to mathematics laboratories: one to present a school-man's practical view of laboratories (Alan Barson), one to review related research (Jack Wilkinson) and one to review evaluation procedures (Donald Kerr and John LeBlanc).

232M ED 104 720
Title: Mathematics Laboratories: 150 Activities and Games for Elementary Schools
Authors: Jon L. Higgins and Larry A. Sachs
Pages: 207
Date: December 1974
Form: Offset, perfect bound
Price: $4.50
Description: Contains 150 activities and games grouped into eight sections: (1) Number Concepts; (2) Addition and Subtraction; (3) Multiplication and Division; (4) Number Skills Review; (5) Measurement; (6) Fractions; (7) Graphs and Functions; and (8) Geometric Concepts.

235M ED 104 666
Title: Research Reporting Sections of the National Council of Teachers of Mathematics 53rd Annual Meeting (1975)
Author: Jon L. Higgins, Editor
Pages: 120
Date: April 1975
Form: Offset, with cover
Price: $2.70
Description: Contains reports of research reported at the NCTM meeting. Abstracts cover a variety of topics related to teaching and learning mathematics. The publication continues the NCTM series.

236M ED 115 488
Title: Materials for Metric Instruction
Authors: Gary G. Bitter and Charles Geer
Pages: 85
Date: August 1975
Form: Offset, with cover
Price: $2.20
Description: This compilation lists available metric kits, task cards, films, filmstrips, slides, and other miscellaneous metric materials. The bibliography is intended as a quick reference or source of information for supplementary metric materials. For each entry the source, cost, level of learning, and a brief description are included.

237M ED 113 152
Title: Algorithmic Learning
Authors: Marilyn N. Suydam and Alan R. Osborne
Pages: 194
Date: 1975
Form: Offset, with cover
Price: $4.15
Description: This volume contains a series of papers on algorithmic learning. Included are six reviews of research pertaining to various aspects of algorithmic learning, six reports of pilot experiments in this area, a theoretical discussion of "The Conditions for Algorithmic Imagination," and an annotated bibliography.

238M ED 120 013
Title: Using Research: A Key to Elementary School Mathematics, Revision
Authors: Marilyn N. Suydam and J. Fred Weaver
Pages: 137
Date: December 1975
Form: Offset, with cover
Price: $3.30
Description: This booklet consists of eleven bulletins designed to answer questions which teachers frequently ask about the learning and teaching of mathematics. (The bulletins are revisions of a set originally published in 1970.) Each bulletin is organized around a central topic, and presents questions related to that topic, summaries of research findings relevant to each question, and a selected bibliography.

239M ED 120 001
Title: Research Reporting Section of the National Council of Teachers of Mathematics 54th Annual Meeting (1976)
Author: Jon L. Higgins, Editor
Pages: 117
Date: April 1976
Form: Offset, with cover
Price: $3.30
Description: Abstracts of 28 research reports are provided. The reports were prepared by investigators for presentation at the 54th annual meeting of the National Council of Teachers of Mathematics. A broad range of topics related to mathematics education are covered.

240M ED 120 027
Title: Number and Measurement. Papers from a Research Workshop
Authors: Richard A. Lesh and David Bradbard
Pages: 238
Date: April 1976
Form: Offset, perfect bound
Price: $4.40
Description: Seven papers presented at a research conference on number and measurement are presented in this volume. The first paper provides an overview of research concerning number and measurement, and suggests directions for future research. The second paper discusses the relationships between measurement and number concepts, and psychological and instructional issues related to transfer. Two papers are devoted to synthesizing and analyzing research on measurement, and the delineation of questions about which research is needed. Two papers are concerned with instruction and research on teaching and learning fractions. The final paper concerns children's development of cardinal and ordinal number concepts.

241M ED 113 206
Title: Learning with Understanding
Author: Herbert A. Simon
Pages: 30
Date: June 1975
Form: Offset, with cover
Price: $1.40
Description: In this paper, Simon describes contemporary information processing approaches to the study of learning and thinking, and discusses the relevance of these studies to the distinction between rote and meaningful learning.

242M ED 121 624
Title: Compilation of Research on College Mathematics Education
Author: Marilyn N. Suydam
Pages: 287
Date: December 1975
Form: Offset, perfect bound
Price: $4.95
Description: This publication consists primarily of a listing of research reports on mathematics education in the United States at the college level. It also includes some studies which were conducted with samples from other post-secondary-school populations. And research conducted with teacher education samples is also included when the focus of the research was on mathematical background or courses. The reports listed include journal articles, dissertations and ERIC documents which were located for the years 1900 through 1974. Articles and dissertations for five recent years, 1970 through 1974, have been annotated to indicate at least one finding that reflects the focus of the research. To aid readers in locating studies on a particular topic, all documents listed have been categorized by mathematical topic.

243M ED 128 226
Title: Models for Learning Mathematics: Papers from a Research Workshop
Author: Alan Osborne and David Bradbard, Editors
Pages: 207
Date: 1976
Form: Offset, perfect bound
Price: $4.40
Description: The general purposes of a model are discussed, then seven papers are presented which demonstrate several different facets of the problems associated with constructing and using models of mathematics learning. The mathematical areas covered by the models include problem solving, geometry, arithmetic computation, counting, and numeration.

244M ED 123 132
Title: Teaching Strategies: Papers from a Research Workshop
Authors: Thomas Cooney and David Bradbard, Editors
Pages: 209
Date: 1976
Form: Offset, perfect bound
Price: $4.40
Description: Nine papers presented at a research conference on strategies for teaching mathematics are presented in this volume. The first paper provides an overview of research on teaching strategies, defining a perspective on the subsequent papers. The second paper reviews the major strategies from an historical perspective. The third paper discusses the role of a theory in the development of teaching strategies. Four papers are concerned with research problems related to teaching strategies. The first of these deals with studies of efficacy of different strategies; the second concerns a comparison of teaching strategies which differed in the amount of information being taught and the amount of pupil-teacher interaction. More general research papers concern problems of designing studies of teaching strategies and a context for studying teaching strategies from a delivery-systems approach. The eighth paper discusses materials for teacher training. The final paper provides an integrative summary of research on teaching strategies.

245M ED 132 033
Title: Space and Geometry: Papers from a Research Workshop
Authors: Larry Martin and David Bradbard, Editors
Pages: 245
Date: 1976
Form: Offset, perfect bound
Price: $4.70
Description: Seven papers presented at a research conference on space and geometry are contained in this monograph. The first paper gives an historical sketch of the development of geometry and discusses several considerations for selecting geometric content for the elementary school. Two papers deal with Piaget's research into the child's development of space and geometry concepts, and another perspective. A fifth paper reviews the van Hiele levels of development in geometry and discusses the new Soviet geometry curriculum, another paper reviews cross-cultural research on perception, and the final paper examines some research issues concerning children's concepts of transformation geometry.

246M ED 142 419
Title: Mathematics Education: A Bibliography of Abstracts from Resources in Education (RIE) from 1973-1975
Authors: Jon L. Higgins and Others
Pages: Over 500
Date: 1976
Form: Offset, loose leaf with 3 hole binder
Price: $18.00
Description: Contains abstracts to nearly all materials related to mathematics education included in Resources in Education 1973-75. This document supplements, but does not replace ED 089 986 (227M). The quick way to locate materials in ERIC.

247M ED 135 670
Title: Research Sections of the National Council of Teachers of Mathematics 55th Annual Meeting (1977)
Authors: Jon L. Higgins, Editor
Pages: 144
Date: December 1976
Form: Offset, with cover
Price: $3.85
Description: Abstracts of 36 research reports are provided. The reports were prepared by investigators for presentation at the 55th annual meeting of the National Council of Teachers of Mathematics. A broad range of topics related to mathematics education is covered. Nine reports deal with problem solving, eight are concerned with instructional methods, five with space and geometry, and four with numbers and operations. Two reports concern reading and writing skills in mathematics, two deal with testing and measurement procedures, and two concern program evaluation. Other papers deal with logic, effective teachers, learning aids for the blind, and models of mathematics learning.

248M ED 128 195
Title: Mathematics Learning: What Research Says About Sex Differences
Authors: Elizabeth Fennema, Editor
Pages: 51
Date: December 1975
Form: Offset, with cover
Price: $1.95
Description: This volume presents four papers originally drafted for a symposium on sex differences and mathematics education. The paper by Fox reviews results of several contests to identify junior high school students who were precocious in mathematical ability, and subsequent instructional experiments aimed at improving the mathematical achievement of able girls. Aiken's paper presents factor analytic data concerning sex differences in attitudes toward mathematics and discusses several hypotheses to explain these differences. Armstrong's paper discusses results of factor analytic studies of sex differences in mathematics and the relationship of this ability to sex differences in mathematics achievement.

249M ED 130 861
Title: Teacher Education in Mathematics
Author: B. Othanel Smith
Pages: 24
Date: September 1976
Form: Offset, with cover
Price: $1.40
Description: An overview of some of the strengths and weaknesses of teacher education programs is presented in this document. Components of teacher education programs are discussed, research in teacher effectiveness is briefly described, and suggestions are given for what is possible and desirable as a program of preparation for mathematics education.

251M ED 147 184
Title: Remedial Mathematics: Diagnostic and Prescriptive Approaches. Papers from the First National Conference on Remedial Mathematics
Authors: Jon L. Higgins and James W. Heddens, Editors
Pages: 134
Date: December 1976
Form: Offset, with cover
Price: $3.85
Description: This publication contains five papers, five reaction papers, and a summary related to diagnostic and remedial mathematics. The first paper discussed procedures for identifying and describing the remedial mathematics student. The second paper discusses methods of classroom diagnosis in mathematics. The third paper presents a model for clinical diagnosis of children with mathematics difficulties. The diagnosis process in mathematics instruction is discussed in the fourth paper. The last paper reviews research related to the remediation of learning difficulties in school mathematics.

252M ED 138 483
Title: Designing Methods Courses for Secondary School Mathematics Teachers. Papers from a Symposium Arranged by the Illinois Council on Mathematics Education
Authors: John A. Shumaker and Meredith W. Potter, Eds.
Pages: 106
Date: January 1977
Form: Offset, with cover
Price: $3.85
Description: Collected in this document are papers presented at a conference on designing mathematics methods courses for secondary school teachers. Papers are organized under the following categories: (1) Realistic goals for a methods course, (2) Minimal content for a methods course, and (3) Teaching strategies used in methods courses.

253M ED 144 840
Title: Activity-Based Learning in Elementary School Mathematics: Recommendations from Research
Authors: Marilyn N. Suydam and Jon L. Higgins
Pages: 178
Date: September 1977
Form: Offset, perfect bound
Price: $3.85
Description: Research conducted in grades K-8 on activity-based teaching approaches, including studies on the use of manipulative materials, is reviewed and synthesized in this report. On the basis of the synthesis, it was concluded that lessons using manipulative materials have a higher probability of producing greater mathematical achievement than do non-manipulative lessons. Use of both manipulative materials and pictorial representations is highly effective; symbolic treatments alone are less effective. The use of materials appears to be effective with children at all achievement levels, ability levels, and socioeconomic levels.

254M ED 146 015
Title: On Clinical Studies in Mathematics Education
Author: J. A. Easley, Jr.
Pages: 40
Date: June 1977
Form: Offset, spiral bound
Price: $1.40
Description: This document was developed to provide some perspectives on the use of case studies and other clinical approaches in mathematics education. A large portion of the paper contrasts several research strategies, discussing in detail some of the procedures and results of three distinctive types of clinical studies. The perspectives and the premises of Erlwanger, Piaget, and several Soviet studies are considered in relation to the techniques and outcomes which result from their work. Then the uses of clinical research methods and results in the classroom are discussed. Finally, references which readers may find useful in additional exploration of clinical approaches are cited.

255M ED 153 840
Title: Research Reporting Sections, Annual Meeting of the National Council of Teachers of Mathematics (56th, San Diego, California, April 12-15, 1978)
Author: Jon L. Higgins, Editor
Pages: 108
Date: March 1978
Form: Offset, spiral bound
Price: $3.30
Description: Abstracts of 28 research reports are provided. The reports were prepared by investigators for presentation at the 56th annual meeting of the National Council of Teachers of Mathematics. A broad range of topics related to mathematics education is covered. Ten reports deal with problem solving, four are concerned with instructional methods, three with space and geometry, two with calculators, two with measurement, and two with conservation. Other papers deal with games, program evaluation, achievement prediction, preception of motion in pictures, and learning difficulties related to numeracy.

256M ED 156 446
Title: Mathematical Problem Solving: Papers from a Research Workshop
Authors: Larry Hatfield and David Bradbard, Editors
Pages: 99
Date: 1978
Form: Offset, perfect bound
Price: $3.05
Description: Five papers presented at a research conference on mathematical problem solving are contained in this monograph. The first paper gives an overview of research on mathematical problem solving, while the second paper discusses variables and methodologies used in problem-solving research. The final three papers deal with instruction in problem-solving, discussing heuristic emphases, Soviet studies, and approaches for elementary schools.

257M ED 159 062
Title: Recent Research Concerning the Development of Spatial and Geometric Concepts
Authors: Richard Lesh and Diane Mierkiewicz, Editors
Pages: 352
Date: 1978
Form: Offset, perfect bound
Price: $6.60
Description: This monograph contains fourteen papers reporting recent research on the development of geometric ideas in children and adults. The papers are divided into three categories: studies concerning preoperational concepts; studies concerning transitional stages from concrete to formal operations; and studies concerning older subjects or formal operational concepts. A fifteenth paper suggests additional research directions in geometry.

258M ED 153 878
Title: The Status of Pre-College Science, Mathematics, and Social Science Education: 1955-1975. Volume II. Mathematics
Authors: Marilyn N. Suydam and Alan Osborne
Pages: 297
Date: 1977
Form: Offset, spiral bound
Price: $7.15
Description: This historical study presents evidence on the status of pre-college mathematics education from 1955 through 1975, based on a review, analysis, and synthesis of the literature. It identifies practices and trends in curriculum, instruction, teacher education, learner performance, and needs assessments during the two-decade period.

259M ED 166 051
Title: Perspectives on Women and Mathematics
Author: Judith E. Jacobs, Editor
Pages: 165
Date: 1978
Form: Offset, perfect bound
Price: $5.50
Description: The papers presented in the strand on "Women and Mathematics" at the 1978 Annual Meeting of the National Council of Teachers of Mathematics form the core of this monograph. Two commentaries synthesizing the presentations and offering additional suggestions for action are also included. The papers consider sex-related differences in mathematics achievement, mathematics problems, affective components, mathematics anxiety, sexism in textbooks, mathophia, factors leading to success and the role of the mathematics education community and others in promoting change. A selected bibliography is also given.

260M ED 167 383
Title: Research Reporting Sections, Annual Meeting of the National Council of Teachers of Mathematics (57th, Boston, Massachusetts, April 18-21, 1979)
Author: Jon L. higgins, Editor
Pages: 77
Date: 1979
Form: Offset, perfect bound
Price: $2.50
Description: This document provides abstracts of 20 research reports. Topics covered include: children's comprehension of simple story problems; field independence and group instruction; problem-solving competence and memory; spatial visualization and the use of manipulative materials; effects of games on mathematical skills; problem-solving ability and right hemisphere processing; effects of calculator use; effects of spatial instruction; conceptualization of subtraction; cognitive processes used in problem-solving; variable discriminating good and poor problem solvers; heuristic hints and the solution processes.

261M SE 027 515
Title: Resources for Teaching Mathematics in Bilingual Classrooms
Author: C. James Lovett and Ted Snyder
Pages: 56
Date: January 1979
Form: Offset, perfect bound
Price: $1.95
Description: A substantial resource is provided for those concerned with mathematics teaching in bilingual programs. Part I provides a concise overview of the issues and problems involved in the teaching of mathematics in bilingual classrooms. It begins with a brief description of the field of bilingual education and then considers the role of mathematics teaching with respect to the language of instruction, cultural referents, and certain psychological factors. Part II consists of an annotated bibliography of materials for teaching mathematics in Spanish/English programs. A list of suppliers of bilingual mathematics materials, a list of references to general bilingual materials, and a phrase list appended.

262M SE 028 799
Title: Mathematics Education: A Bibliography of Abstracts from Resources in Education (RIE) from 1976-1977
Author: Jon L. Higgins and Others
Pages: 531
Date: 1978
Form: Offset, looseleaf
Price: $15.00 (without binder), $18.00 (with binder)
Description: Contains abstracts to nearly all materials related to mathematics education included in Resources in Education (RIE) 1976-77. This document supplements, but does not replace ED 089 986 (227M) or ED 142 429 (246M). The quick way to locate materials in ERIC.

263M SE 027 927
Title: Explorations in the Modeling of the Learning of Mathematics
Authors: Karen C. Fuson and William E. Geeslin, Editors
Pages: 235
Date: March 1979
Form: Offset, spiral bound
Price: $6.00
Description: The papers in this volume focus on the exposition of particular models for mathematical learning which can be used either to predict the outcomes of certain classroom activities or to simulate the actual process of cognition. The models are derived from diverse theoretical bases and address content areas from preschool to college level.

264M
Title: Cryptarithms and Other Arithmetical Pastimes
Authors: N. J. Kuenzi and Bob Prielipp
Pages: 54
Date: May 1979
Form: Offset, perfect bound
Price: $1.75
Description: This publication of the School Science and Mathematics Association contains a collection of cryptarithms and other arithmetical problems culled from the "Mathematics Problems Department" of School Science and Mathematics. Included with each section are hints and solutions.

265M SE 029 662
Title: Calculators: A Categorized Compilation of References
Authors: Marilyn N. Suydam
Pages: 180
Date: June 1979
Form: Offset, perfect bound
Price: $5.50
Description: Provides annotated references that deal with the use of calculators in education. Each entry also includes a limited set of descriptors which denote the focus of the reference. An index is appended.

266M SE 029 444
Title: Task Variables in Mathematical Problem Solving
Authors: Gerald A. Goldin and C. Edwin McClintock, Editors
Pages: 495
Date: November 1979
Form: Offset, spiral bound
Price: $10.00
Description: A framework for research in problem solving is provided by categorizing and defining variables describing problem tasks. A model is presented in the first article for the classification of task variables into broad categories. Other articles define and discuss each category of task variables, give examples, survey the existing research literature, and explore the theoretical implications of task variables within the category.

267M SE 029 663
Title: Applied Mathematical Problem Solving
Authors: Richard Lesh, Diane Mierkiewicz, and Mary Kantowski, Editors
Pages: 257
Date: November 1979
Form: Offset, perfect bound
Price: $6.50
Description: This collection of nine papers, prepared for a conference held at Northwestern University in 1978, presents varied perspectives on applied problem solving. Assessing applied problem solving, planning for interest and motivation, developing a theory, reviewing research findings, considering learning disabilities, analyzing through information processing, designing instruction, trends in research, and models for applied problem solving are presented.

268M SE 029 524
Title: Understanding the Realities of Problem Solving in Elementary School With Practical Pointers for Teachers
Authors: Linda Brandau and Jack Easley
Pages: 66
Date: December 1979
Form: Offset, perfect bound
Price: $2.00
Description: This document is divided into three parts. Part I connects the reality of the classroom with the idealism which arises from some of the problem solving literature. Part II examines what "problem solving" might mean in the context of the elementary school classroom. Part III considers how children can be helped to understand the non-arbitrary character of rules of arithmetic by examining the connectedness of mathematical ideas, rules, and procedures. Also included is a list of reference and recommended readings, a list of specific pointers for teachers, and a conclusions section.

269M SE 029 851
Title: An Analysis of Mathematics Education in the Union of Soviet Socialist Republics.
Authors: Robert B. Davis, Thomas A. Romberg, Sidney Rachlin, and Mary G. Kantowski
Pages: 178
Date: December 1979
Form: Offset, perfect bound
Price: $4.25
Description: The current status of mathematics education in the Union of Soviet Socialist Republics is reported. Sources include personal observations, discussions with Soviet educators, and reports on Soviet research techniques and findings. Discussed are common practices in present Soviet schools, difficulties in language, Soviet mathematics curricula, and mathematics education research and development in the Soviet Union. Soviet approaches to the study of problem-solving processes in mathematics are considered, and a view regarding the value of studying mathematics education research and development in the Soviet Union is presented.

270M SE 029 684
Title: Assessing Mathematical Achievement
Authors: Jon L. Higgins, Margaret Kasten, and Marilyn N. Suydam, Compilers
Pages: 81
Date: December 1979
Form: Offset, spiral bound
Price: $2.50
Description: Compiled to serve as a reference on assessments of achievement in pre-college mathematics, this report contains discussion of patterns of mathematical assessments in terms of the history and nature of assessments of achievement, the relationship between assessment and minimum competency testing, and the current status of state assessment programs. Portions of reports of the National Assessment of Education Progress and the California Assessment, grades 6 and 12, are presented to examine trends in mathematics achievement.

271M SE 029 661
Title: Some Theoretical Issues in Mathematics Education: Papers from a Research Presession
Authors: Richard Lesh and Walter Secada, Editors
Pages: 74
Date: December 1979
Form: Offset, perfect bound
Price: $2.50
Description: Three addresses by internationally renowned mathematics researchers and a fourth paper on the role of research are presented. Each of the addresses focuses on the learning process, but from different points of view. Authors are Heinrich Bauersfeld, Efraim Fischbein, Hans Freudenthal, and Richard Lesh.

272M SE 029 682
Title: Research Reporting Sections, Annual Meeting of the National Council of Teachers of Mathematics (58th, Seattle, Washington, April 16-19, 1980)
Authors: Jon L. Higgins, Editor
Pages: 53
Date: 1980
Form: Offset, perfect bound
Price: $1.75
Description: Presented are abstracts of 14 research reports. Included are such topics as: the effects of games on mathematics skills and concepts, sex differences in mathematics achievement and participation, locus of control and mathematics instruction, and the psychology of problem solving.

273M SE 030 730
Title: A Categorized Listing of Research on Mathematics Education, 1974-1978
Authors: Marilyn N. Suydam
Pages: 354
Date: December 1979
Form: Offset, perfect bound
Price: $8.00
Description: Articles, dissertations, and ERIC documents for the five-year period are included in this compilation. An index cites the research reports by categories for major topics.

274 ED 190 408

Title: International Calculator Review Working Paper on Hand-held Calculators in Schools

Authors: Marilyn N. Suydam

Pages: 97

Date: March 1980

Form: Offset, spiral bound

Price: $3.00

Description: Contains a collection of papers on the status of the use of calculators in the schools of 16 countries. Each report summarizes trends and prevailing opinions about curricular implications of calculators; research activities; instructional practices; student attitudes; in-service activities; and general background on amount and type of use, projects, and other concerns. Includes a synthesis of these national reports and a report of the International Working Group on Calculators from a meeting in January, 1980.

275M ED 194 350

Title: Interactions of Science and Mathematics: A Set of Activities. SSMA, Topics for Teachers Series, Number 2

Authors: Peggy A. House

Pages: 185

Date: April 1980

Form: Offset, perfect bound

Price: $6.00

Description: Provides a wide range of simple experiments involving one or more concepts of secondary school mathematics and utilizing simple, easily obtainable equipment. Experiments are grouped into these categories: functions; measurement; ratio and proportion; spatial relationships; and modeling, predicting, and decision making. Teaching notes and suggestions for other activities and applications are appended to each section.

276M SE 033 673

Title Research Reporting Section, Annual Meeting of the National Council of Teachers of Mathematics (59th, St. Louis, MO, April 22-25, 1981)

Authors: Jon L. Higgins, Editor

Pages: 55

Date: 1981

Form: Offset, perfect bound

Price: $1.75

Description: Presents abstracts of 18 research reports covering various aspects of mathematics learning in young (kindergarten and elementary) children; the diagnosis of word problem difficulties of sixth graders; mathematics instruction; calculator use; problem solving; cognitive style; cognitive strategies of children with mathematical learning disorders.

277M SE 034 210
Title: Especially for Teachers: ERIC Documents on Teaching of Mathematics, 1966-1980
Authors: Marilyn N. Suydam and Jon L. Higgins, Compilers
Pages: 212
Date: February 1981
Form: Offset, drilled for three-hole notebook
Price: $6.50; $1.50 extra for binder copy
Description: Presented are over 900 citations on materials on mathematics instruction for teachers. These citations were selected from documents listed in Resources in Education (RIE) between 1966 and 1980. Subject and author indexes are also included.

Title: Programmable Calculators: Implications for the Mathematics Curriculum
Authors: Mark A. Spikell, Editor
Pages: 112
Date: December 1980
Form: Offset, perfect bound
Price:
Description: The 13 papers in this collection were presented in a symposium at the 58th Annual Meeting of the National Council of Teachers of Mathematics, held in Seattle in April 1980. The papers describe curricular materials prepared for mathematics courses in grades 11 and 12, geometry, algebra, probability and statistics, and trigonometry. Uses of calculators for problem solving, enrichment, and independent study, and as a means of focusing on significant mathematical ideas, are discussed.

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SAMPLE BASIC PROGRAMS

The following programs have been written in floating point BASIC for an Apple microcomputer. With minor modifications, the programs should work on other microcomputer systems.

The programs have been written to be representative of various computer capabilities and applications that are relevant to mathematics and/or education.

Name in Lights is an ice-breaking program which asks the viewer to enter his/her name and proceeds to manipulate that name about the screen through various string operations.

Dice Simulation permits the user to simulate the roll of two dice for any number of times entered and to compare the actual results with those predicted by probability theory. The program illustrates the use of loops, random numbers, and one-dimensional arrays.

Bar Graphs creates a simple horizontal bar graph through READ and DATA statements. The viewer is encouraged to create his/her own bar graph by replacing the data statements with new data to be displayed. The core program appears in the rectangles.

Simulation - Coin Flips simulates 100 trials of the flip of a coin ten times. The number of heads occurring in each ten flips is recorded, summarized, and then displayed on a bar graph. Loops, random numbers, and one-dimensional arrays are illustrated.

Stopwatch turns the screen into a digital stopwatch displaying elapsed hours, minutes, and seconds. This program could be used as a subprogram in a larger game program. FOR-NEXT loops and GOSUB commands are highlighted.

Line Editor permits the entry of text through DATA statements with breaks at the end of the screen occurring at word endings instead of the usual wrap-around effect. Various string functions are illustrated in the program.

Educational Jargon is a fun program that uses random numbers to cause the computer to invent three-to-four word educational phrases. FOR-NEXT loops are used in conjunction with READ-DATA statements.

Least Common Multiples illustrates the computer's capability to be a number cruncher. Multiples of two input numbers are shown with the least common multiple flashing on the screen. Loops, conditional statements, and one-dimensional arrays are emphasized.

Systems of Equations presents a common program for solving a system of n linear equations in n unknowns. After the input of the coefficient and constant matrices, the system and solution are displayed. GOSUB statements, FOR-NEXT loops, and two-dimensional arrays are illustrated.

NAME IN LIGHTS

```
 70  CALL - 936
 80  PRINT " * * * *  YOUR NAME IN LIGHT  * * * *"
 90  VTAB 8
100  INPUT "ENTER YOUR FIRST NAME PLEASE:   ";F$
110  PRINT : PRINT
120  INPUT "ENTER YOUR LAST NAME PLEASE:   ";L$
130  PRINT : PRINT
140  PRINT "   HI!   ";F$;" ";L$
142  PRINT
145  PRINT "   DID YOU KNOW THAT YOUR FULL NAME HAS "
147  PRINT
148  PRINT  LEN (F$) + LEN (L$) " CHARACTERS."
149  FOR T = 1 TO 5000: NEXT T
150  CALL - 936
160  VTAB 8
170  PRINT "   NOW I WOULD LIKE TO SHOW YOU SOME"
180  PRINT
190  PRINT "INTERESTING THINGS THAT I CAN DO WITH"
200  PRINT
210  PRINT "YOUR NAME.  OK?  (PUSH 'Y' AND 'RETURN'"
215  PRINT
220  PRINT "TO CONTINUE)"
230  INPUT R$
240  IF R$ = "Y" GOTO 260
250  PRINT "DON'T BE BASHFUL...SAY YES!": GOTO 230
260  CALL - 936
270  N$ = F$ + " " + L$
280  W = LEN (F$) : Z = LEN (L$)
285  Y = (W + Z) / 2 + ABS (W-Z) / 2
290  FOR B = 1 TO 3
295  FOR K = 1 TO Y
300  PRINT TAB(20 - K) LEFT$ (F$,K);
305  PRINT TAB(21) RIGHT$ (L$,K)
310  FOR I = 1 TO 300: NEXT I
315  NEXT K
320  FOR K = 1 TO Y
325  PRINT TAB(19 - Y + K) LEFT$(F$,Y + 1 - K);
330  PRINT TAB(21) RIGHT$(L$,Y + 1 - K)
335  FOR I = 1 TO 300: NEXT I
340  NEXT K
350  NEXT B
360  FOR I = 1 TO 1000: NEXT I: CALL - 936
365  FOR B = 1 TO 3
370  FOR X = 1 TO 22
375  FOR Z = 1 TO X
380  HTAB X
390  VTAB Z
400  PRINT N$
410  NEXT Z
420  NEXT X
425  NEXT B
430  FOR I = 1 TO 1000: NEXT I
440  CALL - 936
```

NAME IN LIGHTS (CONT'D)

```
470  FOR K = 1 TO Y
490  HTAB (40 - K)
500  PRINT LEFT$(F$,K);
510  HTAB 1
520  PRINT RIGHT$(F$,K)
530  FOR I = 1 TO 250: NEXT I
540  CALL - 936
550  NEXT K
560  FOR K = 1 TO 30
570  HTAB (40 - LEN(L$) - K)
575  PRINT L$;
580  HTAB (1 + K)
585  PRINT F$
590  FOR I = 1 TO 250: NEXT I
600  NEXT K
610  FOR I = 1 TO 250: NEXT I
620  FOR K = 1 TO 30
630  CALL - 936
640  VTAB 24
650  HTAB (40 - LEN (F$) - K)
660  PRINT F$;
670  HTAB (1 + K)
680  PRINT L$
690  FOR I = 1 TO 250: NEXT I
700  NEXT K
710  FOR I = 1 TO 1000: NEXT I
720  B = 0
730  FOR T = .25 TO 20 STEP .25
740  A = INT (16 + 15 * SIN (T))
745  FOR K = 1 TO 150: NEXT K
750  PRINT TAB(A);
760  IF B = 1 GOTO 800
770  PRINT F$
780  B = 1
790  GOTO 820
800  PRINT L$
810  B = 0
820  NEXT T
830  FOR I = 1 TO 1000: NEXT I
835  CALL - 936
840  VTAB 8
850  PRINT "  WELL, IT'S BEEN NICE MEETING YOU."
855  PRINT
860  PRINT "I HOPE YOU ENJOYED YOUR NAME IN LIGHTS."
870  PRINT: PRINT
880  PRINT "GOODBYE FOR NOW ";N$;"!"
890  FOR I = 1 TO 5000: NEXT I
900  GOTO 70
```

DICE SIMULATION

```
40   PRINT TAB(12) "DICE SIMULATION"
50   DIM T(12)
55   VTAB 6
60   PRINT "  THIS IS A SIMULATION FOR THROWING TWO"
65   PRINT
70   PRINT "DICE SOME NUMBER OF TIMES OF YOUR"
75   PRINT
80   PRINT "CHOOSING."
90   FOR K = 1 TO 5000: NEXT K
100  PRINT: PRINT
110  PRINT "  THE PROGRAM COMPARES THE SIMULATED"
115  PRINT
120  PRINT "RESULTS WITH THEORETICAL PREDICTIONS."
130  FOR K = 1 TO 5000: NEXT K
140  CALL - 936
150  INPUT "  HOW MANY ROLLS OF THE DICE WOULD YOU LIKE?   ";N
153  FOR S = 1 TO 12
155  T(S) = 0
157  NEXT S
160  CALL - 936
162  VTAB 8
165  PRINT TAB(11) "I'M WORKING ON IT!"
170  FOR I = 1 TO N
180  D1 = INT (6 * RND (1)) + 1
190  D2 = INT (6 * RND (1)) + 1
200  S = D1 + D2
210  T(S) = T(S) + 1
220  NEXT I
224  CALL - 936
227  VTAB 6
230  PRINT TAB(8) "RESULTS FOR ";N;" ROLLS"
240  PRINT
260  PRINT TAB(19) "ACTUAL"; TAB(28) "THEORET"
270  PRINT "TTL"; TAB(9) "FREQ"; TAB(20) "PCT"; TAB(30) "PCT"
275  PRINT
280  For K = 2 TO 12
285  R = ABS (K - 7)
290  PRINT K;"'S"; TAB(10) T(K);
300  PRINT TAB(20) INT (1000 * T(K) / N + .5) / 1000;
310  PRINT TAB(30) INT (((6 - R) / 36) * 1000 + .5) / 1000
320  NEXT K
330  PRINT
340  INPUT "   WOULD YOU LIKE ANOTHER RUN?   ";Q$
350  IF Q$ = "Y" GOTO 140
360  END
```

BAR GRAPHS

```
90   CALL - 936
100  PRINT TAB(15) "BAR GRAPHS"
110  PRINT: PRINT
120  PRINT "  THIS PROGRAM PERMITS YOU TO CONSTRUCT": PRINT
130  PRINT "A BAR GRAPH USING LABELS AND DATA OF": PRINT
140  PRINT "YOUR CHOOSING.  YOU MAY SELECT UP TO TEN": PRINT
150  PRINT "CATEGORY NAMES FOR YOUR DATA.": PRINT
160  PRINT "  THE DATA MAY BE ANY WHOLE NUMBERS": PRINT
170  PRINT "BETWEEN 0 AND 32.": PRINT: PRINT
180  PRINT "  THE FOLLOWING IS AN EXAMPLE.": PRINT: PRINT
190  INPUT "  PRESS 'RETURN' TO CONTINUE.";C$
200  CALL - 936
204  REM: T$ IS THE TITLE YOU CHOOSE FOR THE GRAPH
205  T$ = "FAMILY CAR COLORS - CLASS OF 29"
208  REM: N SETS THE NUMBER OF CATEGORIES FOR YOUR GRAPH
210  N = 10
220  PRINT TAB( INT (40 - LEN(T$)) / 2) T$
230  FOR I = 1 TO N
235  REM: STATEMENTS 250 AND 260 ASSUME CATEGORY NAMES
240  REM: ARE WORDS OR LETTERS.  IF THEY ARE NUMBERS, REPLACE
245  REM: R$ WITH R AND USE NO " " MARKS IN DATA STATEMENTS.
250  READ R$,D
255  PRINT
260  PRINT R$;
265  HTAB(9)
270  IF D = 0 GOTO 305
280  FOR J = 1 TO D
290  PRINT "X";
300  NEXT J
305  PRINT
310  NEXT I
320  FOR K = 1 TO 5000: NEXT K
330  INPUT "  PRESS 'RETURN' TO CONTINUE.";C$
340  CALL - 936
350  VTAB 8
360  PRINT "  WITH MINOR CHANGES IN THE PROGRAM YOU": PRINT
370  PRINT "CAN DISPLAY YOUR OWN BAR GRAPH DATA.": PRINT: PRINT
380  PRINT "  SUBSTITUTE YOUR OWN GRAPHICAL": PRINT
390  PRINT "INFORMATION IN THE PROGRAM DATA": PRINT
400  PRINT "STATEMENTS.  THE REMARKS (REM) IN THE": PRINT
410  PRINT "PROGRAM TELL YOU ANY OTHER CHANGES YOU": PRINT
420  PRINT "ALSO NEED TO MAKE.  HAVE FUN!"
430  END
700  DATA "GREEN",11,"YELLOW",4,"RED",8
710  DATA "GOLD",2,"BROWN",1,"BLUE",16
720  DATA "WHITE",0,"BLACK",3,"GRAY",5
730  DATA "WINE",8
```

SIMULATION - COIN FLIPS

```
1   DIM A(10)
2   FOR D = 0 TO 10
3   LET A(D) = 0
4   NEXT D
5   REM - COIN FLIP SIMULATION:  HEADS IN 10 FLIPS DONE 100 TIMES
          AND GRAPHED
6   HOME
7   PRINT "EVENT:  HEADS IN 10 FLIPS - 100 TRIALS"
8   PRINT
10  FOR I = 1 TO 100
15  H = 0
20  FOR J = 1 TO 10
30  IF RND (1) < .5 THEN 50
40  LET H = H + 1
50  NEXT J
60  PRINT H;" ";
70  LET A(H) = A(H) + 1
80  NEXT I
85  REM - GRAPHS DISTRIBUTION BY NUMBER OF HEADS
90  PRINT: PRINT " - - - - - - - SUMMARY - - - - - - -"
95  PRINT
100 FOR K = 0 TO 10
110 PRINT K;"   ";
120 FOR L = 0 TO A(K) - 1
125 IF A(K) = 0 THEN 140
130 PRINT "X";
140 NEXT L
150 PRINT " "; A(K)
160 NEXT K
170 PRINT: PRINT
180 INPUT "DO YOU WISH ANOTHER RUN?"; Q$
190 IF Q$ = "Y" GOTO 2
195 CALL - 936
200 IF Q$ = "N" GOTO 210
205 IF Q$< >"N" THEN PRINT "PLEASE PRESS (Y) OR (N) AND HIT RETURN." : PRINT :
        GOTO 180
210 END
```

original program from Richard Shumway
Ohio State University

STOPWATCH

```
 50  REM - TURNS SCREEN INTO A STOPWATCH
 60  CALL - 936
 70  PRINT TAB(15) "STOPWATCH"
 80  GOSUB 165
 90  PRINT : PRINT
100  PRINT TAB(6) "PRESS 'CTRL C' TO STOP TIMER"
105  GOSUB 165
110  PRINT : PRINT
120  PRINT "PRESS 'CTRL S' TO CAUSE TIMER TO PAUSE"
125  GOSUB 165
130  PRINT : PRINT
140  PRINT TAB(7) "PRESS ANY KEY TO CONTINUE"
145  GOSUB 165
150  PRINT : PRINT
160  PRINT TAB(4) "ENTER ANY NUMBER TO START TIMER"
162  GOTO 170
165  FOR K = 1 TO 1500 ; NEXT K
167  RETURN
170  INPUT N
180  H = 0 ; M = 0 ; S = 0
190  CALL - 936
200  PRINT TAB(13) "DIGITAL TIMER"
210  VTAB 10
220  PRINT TAB(6) "HRS  ";H;"  :  MIN  ";M;"  :  SEC  ";S
230  GOSUB 310
240  S = S + 1
250  IF S = 60 THEN 270
260  GOTO 210
270  S = 0 : CALL - 936
280  M = M + 1
290  IF M = 60 THEN 330
300  GOTO 200
310  FOR T = 1 to 750 : NEXT T
320  RETURN
330  M = 0 : CALL - 936
340  H = H + 1
350  IF H = 24 THEN 180
360  GOTO 200
```

LINE EDITOR

```
2040   CALL - 936
2050   HTAB 10:  PRINT "SUBROUTINE FOR LINES"
2060   HTAB 8:  PRINT "BREAKING AT WORD ENDINGS"
2070   VTAB 8
2080   READ T2$:  REM - SELECTS TEXT TO BE PRINTED FROM A DATA STATEMENT
2090   PRINT: PRINT
2100   K = 40:  REM - SETS NUMBER OF CHARACTERS IN SCREEN WIDTH
2120   FOR N = 1 TO LEN (T2$)
2130   R$ = MID$ (T2$,N,K)
2150   FOR L = 1 TO 10
2160   R = ASC (RIGHT$ (R$,L))
2170   IF R = 32 THEN GOTO 2190
2180   IF R < >32 THEN NEXT L
2190   IF ASC (LEFT$ (R$,1)) = 32 THEN 2210
2200   IF ASC (LEFT$ (R$,L))< >32 THEN 2220
2210   PRINT MID$ (T2$,N,K1): GOTO 2240
2220   K1 = K - L
2230   PRINT MID$ (T2$,N,K1)
2240   N = N + K - L
2250   NEXT N
2260   GOTO 2080
9000   DATA "THIS IS HOW TEXT LOOKS WHEN PRINTED ON THE SCREEN USING
            THIS PROGRAM.  HOW DO YOU LIKE IT?"
9010   DATA "IF YOU WISH TO ADD MORE TEXT, JUST PUT ADDITIONAL MATERIAL
            YOU WOULD LIKE TO SEE PRINTED IN DATA STATEMENTS LIKE THIS
            ONE."
```

EDUCATIONAL JARGON

```
100  PRINT TAB(17) "JARGON"
110  VTAB 6
120  GOSUB 390
130  PRINT" THIS PROGRAM PRINTS EDUCATIONAL JARGON"
140  GOSUB 390
150  PRINT "THAT YOU CAN WORK INTO ENLIGHTENED"
160  GOSUB 390
170  PRINT "CONVERSATION WITH COLLEAGUES."
180  GOSUB 390
190  PRINT : PRINT " OR YOU CAN PUT THESE PHRASES INTO"
200  GOSUB 390
210  PRINT "REPORTS TO IMPRESS YOUR SUPERIORS."
220  GOSUB 390
230  CALL - 936
240  PRINT TAB(16) "PHRASES"
245  PRINT : PRINT
250  DIM W$(40)
260  FOR I = 1 to 39 : READ W$(I) : NEXT I
265  FOR X = 1 to 8
270  PRINT W$( INT (13 * RND (1) + 1));" ";
280  PRINT W$( INT (13 * RND (1) + 14));" ";
290  PRINT W$( INT (13 * RND (1) + 27)): PRINT
310  NEXT X
320  PRINT
330  INPUT "DO YOU NEED MORE JARGONESE? (Y) OR (N)";J$
340  CALL - 936
350  IF J$ = "Y" GOTO 265
360  END
390  FOR P = 1 to 1500 : NEXT P : PRINT : RETURN
400  DATA "ABILITY", "BASAL", "BEHAVIORAL", "CHILD-CENTERED"
410  DATA "DIFFERENTIATED", "DISCOVERY", "FLEXIBLE", "HETEROGENEOUS"
420  DATA  "HOMOGENEOUS", "MANIPULATIVE", "MODULAR", "TAVISTOCK"
430  DATA "INDIVIDUALIZED", "LEARNING", EVALUATIVE", "OBJECTIVE"
440  DATA "COGNITIVE", "ENRICHMENT", "SCHEDULING", "HUMANISTIC"
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470  DATA "ACCOUNTABILITY", "PROCESS", "CORE CURRICULUM", "ALGORITHM"
480  DATA "PERFORMANCE", "REINFORCEMENT", "OPEN CLASSROOM", "RESOURCE CENTER"
490  DATA "STRUCTURE", "FACILITY", "ENVIRONMENT"
```

LEAST COMMON MULTIPLES

```
 70  DIM A(50)
 80  DIM B(50)
 90  CALL - 936
100  PRINT TAB(9) "THE LCM OF TWO NUMBERS"
110  PRINT : PRINT
120  PRINT "FOR WHAT TWO NUMBERS DO YOU WISH TO FIND THE LCM?  (PLEASE
     ENTER THE SMALLER NUMBER FIRST)
130  PRINT
140  INPUT "   M = ";M
150  PRINT
160  INPUT "   N = ";N
170  CALL - 936
175  VTAB 8
180  PRINT TAB(3) "I'M THINKING! . . . I'M THINKING!"
230  X = 1 : R = 10
240  FOR I = X TO R
245  IF I > 50 THEN GOTO 460
247  REM - IF DIM A(50) OR DIM B(50) IS EXCEEDED, 245 IS USED; CHANGE THE
     DIMENSION SETTINGS TO GET A LENGTHENED SEARCH
250  A(I) = M * I
260  FOR J = 1 TO R
270  B(J) = N * J
275  IF B(J) > A(I) GOTO 300
280  IF B(J) = A(I) GOTO 320
290  NEXT J
300  NEXT I
310  X = R + 1 : R = R + 10: GOTO 240
320  CALL - 936
330  FOR K = 1 TO R
335  NORMAL
340  IF M * K < > B(J) THEN PRINT " ";M * K;" ";
345  IF M * K = B(J) THEN FLASH : PRINT " ";M * K;" ";
350  NEXT K
360  PRINT : PRINT
370  FOR K = 1 TO R
380  IF N * K < > B(J) THEN PRINT " ";N * K;" ";
390  NEXT K
400  PRINT : PRINT
410  PRINT "THE LCM FOR  ";M;"  AND  ";N;"  IS:  ";B(J)
420  PRINT
430  INPUT "WOULD YOU LIKE TO CONTINUE?  ";Q$
440  IF Q$ = "Y" GOTO 90
450  END
460  CALL - 936
470  VTAB 8
480  PRINT TAB(5) "I GIVE UP!  BUT DID YOU REMEMBER"
490  PRINT
500  PRINT "TO ENTER THE SMALLER NUMBER FIRST?"
510  PRINT : PRINT
520  GOTO 430
```

SYSTEMS OF EQUATIONS

```
100  PRINT TAB(5) "SIMULTANEOUS LINEAR EQUATIONS"
110  PRINT : PRINT
120  INPUT "ENTER THE NUMBER OF EQUATIONS: ";R
130  DIM A(R,R+1)
140  PRINT
150  REM - ENTER COEFFICIENT MATRIX
160  FOR J = 1 TO R
170  PRINT "EQUATION ";J
180  FOR I = 1 TO R + 1
190  IF I = R + 1 GOTO 220
200  PRINT "   COEFFICIENT X";I;" = ";
210  GOTO 230
220  PRINT "   CONSTANT";" = ";
230  INPUT A(J,I)
240  NEXT I
250  NEXT J
255  GOSUB 540
260  FOR J = 1 TO R
261  REM - STATEMENTS 265 TO 300 SELECT THE FIRST EQUATION WITH A
     NON-ZERO COEFFICIENT FOR THE CURRENT COLUMN
265  FOR I = J TO R
270  IF A(I,J)< > 0 THEN 310
280  NEXT I
290  PRINT "THE SYSTEM DOES NOT HAVE A UNIQUE SOLUTION."
300  GOTO 530
301  REM - STATEMENTS 310 TO 340 MOVE THAT EQUATION UP TO THE CURRENT ROW
310  FOR K = 1 TO R + 1
320  X = A(J,K)
325  A(J,K) = A(I,K)
330  A(I,K) = X
340  NEXT K
341  REM - STATEMENTS 350 TO 380 PRODUCE A COEFFICIENT OF 1 IN THE FIRST
     NON-ZERO COLUMN OF THE CURRENT ROW
350  Y = 1 / A(J,J)
360  FOR K = 1 TO R + 1
370  A(J,K) = Y * A(J,K)
380  NEXT K
381  REM - STATEMENTS 390 to 450 SUBTRACT THE CURRENT EQUATION FROM THE
     OTHER ROWS
390  FOR I = 1 TO R
400  IF I = J GOTO 450
410  Y = - A(I,J)
420  FOR K = 1 TO R + 1
430  A(I,K) = A(I,K) + Y * A(J,K)
440  NEXT K
450  NEXT I
451  REM - PROCESS REPEATED FOR ALL EQUATIONS
460  NEXT J
470  PRINT
480  FOR I = 1 TO R
490  PRINT TAB(19) "X";I;" = "; INT (A(I,R + 1) * 1000 + .5) / 1000
500  NEXT I
510  END
540  CALL - 936
550  PRINT TAB(13) "FOR THE SYSTEM"
560  PRINT : PRINT
600  FOR J = 1 TO R
610  FOR I = 1 TO R - 1
615  IF A(J,1) < 0 THEN PRINT TAB(7) A(J,I);" X";I;" ";: GOTO 630
620  PRINT TAB(8) A(J,I);" X";I;" ";
630  IF A(J,I+1) > = 0 THEN PRINT "+";
640  NEXT I
650  PRINT A(J,R);" X";R;" = ";A(J,R+1)
660  NEXT J
670  PRINT : PRINT
680  PRINT "THE SOLUTION IS:"
690  RETURN
```

Computer Hardware Comparisons and Criteria

Is comparing one computer to another the same process as comparing "apples (sic) to oranges?" The major frustration appears to be that each machine has its strengths and weaknesses and there are too many measuring criteria. Is it better to buy a 4K (bytes of random access memory) machine for $500 or a 16K machine for $1200? Regretfully, the question is seldom that simple. Often one would have to consider other variables--do you need color graphics? Will you plan to buy a disk drive for your machine? . . . and so forth. The saddest aspect of the problem is that the time one needs the most knowledge about computer hardware is just before he or she is about to acquire that knowledge--that time is just before the purchase. If the prospective buyer has a strong background in computers, is familiar with the differences among the machines available, and knows how the computer will be used for at least the next several years, then there is no problem. That person can easily buy the best machines for the proposed use. Most of us cannot imagine all the uses we will find for the new computer. It's hard to guess if we will need a 16K machine or a 48K machine. Could we live without color graphics? Probably, but do we want to?

Deciding which computer to purchase is a difficult decision. This paper draws from several articles of comparisons to point out some of the differences among machines. Salespeople are another resource. Two major suggestions are offered to the prospective buyer.

1. Try to determine the final system you expect to own. Don't decide to buy computer X with 16K because that's all you can afford now. If you plan to develop a 48K system with two disk drives and other features, determine which computers could grow into the system you want and what the final cost would be. Then after you have identified one or more such computer, see if you could purchase some or all components now.

2. Try to talk with owners/users of all the systems you are considering. Often, salespeople can put you in touch with some of their users. Few people seem inclined to discredit the machine they are using--human nature encourages us to justify the "wise" decision we made to purchase brand X! However, the wise shopper can ask revealing questions. "What sort of jobs do you do with your computer?" "How many programs have you written?" "What do they do?" This exploration may help you discover that some machines are better adaptable to uses of interest to you.

On the following pages we have assembled tables of characteristics for many of the microcomputers available in 1981.

Computer/Models	APF PeCos I	Bally Comp. Sys
Microprocessor	6502	Z-80
Memory RAM/ROM (K)	16/24	4/16
Languages	PeCos	4K BASIC
Keyboard		
Case		
Machine Language Monitor		
Color and Graphics Resolution	B/W 40 x 16	Color 160 x 192
Text		
Expansion		
Realtime or Hardware Clock		
I/O Posts		
Built-in Audio		
Audio Cassette	Dual Tape	Tape box available
Disk Capacity		
Video Display	B/W, included	Color, not included
Price	$1695.	$300.

Computer/Models	Apple II or Bell and Howell Apple II	Apple II or Bell and Howell Apple II
Microprocessor	6502	6502
Memory RAM/ROM (K)	16/12	48/12
Languages	Integer BASIC (20 commands, 30 statements, 8 functions, 15 error messages). Apple Soft BASIC (12 commands, 48 statements, 27 functions, 19 error messages). FORTRAN, PASCAL, PILOT.	
Keyboard	Typewriter, n-key rollover, upper case only.	Typewriter, n-key rollover, upper case only.
Case	Beige plastic (Apple) Black plastic (B & H)	Beige plastic (Apple) Black plastic (B & H)
Machine Language Monitor	Yes	Yes
Color and Graphics Resolution	40 x 40, 16 colors 280 x 160, 6 colors	40 x 40, 16 colors 280 x 160, 6 colors
Text	24 x 40 uppercase only Video reverse and blink (lower case adaptor available)	
Expansion	8 general purpose I/O slots for disks, printers, speech board clocks, etc.	
Realtime or Hardware Clock	Optional plug-in board.	Optional plug-in board.
I/O Posts	Game paddles.	Game paddles
Built-in Audio	1 voice.	1 voice.
Audio Cassette	Tape jack	Tape jack
Disk Capacity	108K, 4 drives	108K, 4 drives
Video Display	Color, not included.	Color, not included.
Price	$1195.	$1795.

Computer/Models	Commodore PET I	Commodore PET III
Microprocessor	6502	6502
Memory RAM/ROM (K)	8/14	32/14
Languages	Commodore BASIC 7 commands, 26 statements, 17 functions, 23 error messages	
Keyboard	Typewriter n-key rollover, upper-lower case	
Case	Beige metal case	
Machine Language Monitor	No	No
Color and Graphics Resolution	B/W 64 graphics characters	B/W 64 graphics characters
Text	25 x 40 upper/lower or upper/graphics video reverse	
Expansion	EEE-488 Bus, printer	
Realtime or Hardware Clock	Yes	Yes
I/O Posts	Parallel post	Parallel post
Built-in Audio	No	No
Audio Cassette	500 baud	500 baud
Disk Capacity	1	1
Video Display	Built-in B & W monitor	Built-in B & W monitor
Price	$795.	$1195.

Computer/Models	Compucolor II	Compucolor V
Microprocessor	8080	8080
Memory RAM/ROM (K)	8/16	32/16
Languages	Disk BASIC 8001: 3 commands, 29 statements, 27 functions	
Keyboard	Typewriter, upper case and graphics	
Case	Simulated wood grain and beige plastic	
Machine Language Monitor	No	No
Color and Graphics Resolution	64 x 16, 8 colors	128 x 128, 8 colors 64 graphics characters
Text	32 x 64, in color	32 x 64, in color
Expansion	2nd disk drive, expanded keyboards	
Realtime or Hardware Clock	Yes	Yes
I/O Posts	RS-323	RS-232
Built-in Audio	No	No
Audio Cassette	No (floppy disk built-in)	
Disk Capacity	51K, 2 drives	51K, 2 drives
Video Display	Color monitor, included	
Price	$995.	$1995.

Computer/Models	Exidy Sorcerer	Exidy Sorcerer
Microprocessor	Z-80	Z-80
Memory RAM/ROM (K)	8/12	32/12
Languages	8K BASIC	8K BASIC
Keyboard		
Case		
Machine Language Monitor		
Color and Graphics Resolution	B & W 240 x 512	B & W 240 x 512
Text		
Expansion		
Realtime or Hardware Clock		
I/O Posts		
Built-in Audio		
Audio Cassette	Tape jacks	Tape jacks
Disk Capacity		
Video Display	B & W, not included	B & W, not included
Price	$895.	$1395.

Computer/Models	Heath WH-8	Interact ONE-16
Microprocessor	8080	8080
Memory RAM/ROM (K)	8/1 *	16/2
Languages	*	2K BASIC (8K BASIC available)
Keyboard		
Case		
Machine Language Monitor		
Color and Graphics Resolution	*	Color 112 x 77
Text	*	
Expansion	*	
Realtime or Hardware Clock	*	
I/O Posts	*	
Built-in Audio	*	
Audio Cassette	*	Tape
Disk Capacity	*	
Video Display		Color, not included
Price	$725.	$600.

*Optional accessories for all configurations.

Computer/Models	Ohio Scientific Challenger	Processor Tech Sol 11-A
Microprocessor	6502	8080
Memory RAM/ROM (K)	4/8	60/2
Languages	8K BASIC	12K BASIC
Keyboard		
Case		
Machine Language Monitor		
Color and Graphics Resolution	B & W 256 x 256	B & W 64 x 16
Text		
Expansion		
Realtime or Hardware Clock		
I/O Posts		
Built-in Audio		
Audio Cassette	Tape jacks	Tape
Disk Capacity		Dual disk available
Video Display	B & W, not included	B & W, included
Price	$349.	$2795.

Computer/Models	Radio Shack TRS 1/16	Radio Shack TRS 11/16
Microprocessor	Z-80	Z-80
Memory RAM/ROM (K)	16/4	16/12
Languages	4K BASIC	8K BASIC 14 commands, 32 statements, 36 functions, 23 error messages.
Keyboard	Typewriter, 2-key rollover, upper-lower case, number pad	
Case	Grey and black plastic	
Machine Language Monitor	No	No
Color and Graphics Resolution	B & W, 48 x 128 pixels	
Text	16 lines x 64 characters wide, upper case only	
Expansion	Expansion interface, 1-4 disk drives, modem, voice synthesizer, printers	
Realtime or Hardware Clock	In expansion interface	
I/O Posts	None	None
Built-in Audio	No	No
Audio Cassette	500 baud, motor control	
Disk Capacity	Drive 1, 56 K, drive 2-4, 82 K	
Video Display	B & W monitor included	
Price	$889.	$988.

Computer/Models	RCA VIP	Umtech VB 400
Microprocessor	1802	E8
Memory	2/5	2/17
Languages	CHIP 8	APL
Keyboard		
Case		
Machine Language Monitor		
Color and Graphics Resolution	B & W 32 x 178	Color 200 x 400
Text		
Expansion	Plug-in options available	Modem, tape box available
Realtime or Hardware Clock		
I/O Posts		
Built-in Audio		
Audio Cassette		Tape jacks
Disk Capacity		
Video Display	B & W, not included	Color, not included
Price	$249.	$650.

Computer/Models	Atari 800	TI 99/4
Microprocessor		
Memory	8-48K RAM 8-32K Cartridge 8K ROM Internal	16K RAM 30K ROM Cartridge 26K ROM Internal
Languages	Atari BASIC	TI BASIC: ANSI BASIC with sound and graphics. 14 commands, 33 statements, 19 functions.
Keyboard	Typewriter, upper-lower case.	Typewriter
Case	Beige plastic.	Grey and black plastic.
Machine Language Monitor	No	No
Color and Graphics Resolution	380 x 192, 16 colors	192 x 256, 16 colors
Text	24 x 40, upper-lower case	24 x 32
Expansion	printer, disks, modem	Speech synthesizer, modem, printer, cassette recorder, disk drives
Realtime or Hardware Clock	Interval timer	Interval timer
I/O Posts	Game paddle, light pen	General-purpose I/O post, RS-232 option
Built-in Audio	4 voices	3 voices, noise generator
Audio Cassette	600 baud	Optional 1300 baud
Disk Capacity	80K, 6 drives	80K, 4 drives
Video Display	Requires color TV	Color TV monitor included
Price	$1000.	$1150.

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ACQUISITION OF COMPUTER FACILITIES

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Many people with limited knowledge about computers are being placed in a position of helping to acquire an instructionally-oriented computer facility. This article is intended primarily for such people. It gives a broad general overview of the acquisition process in terms understandable to a person with limited knowledge about computers. If you no longer fall into this category you may still find the article provides a useful summary and overview of the acquisition process.

A computer system consists of both hardware (physical machinery) and software (computer programs). One may purchase, lease, or lease-purchase both the hardware and the software components of a computer system. The individual hardware and software components may be acquired from a single vendor or from a number of vendors. At one time the major cost of a computer system was for the hardware. Now there are many situations in business and industry where the software for a computer system costs several times as much as the hardware. Thus, software may be the dominant factor in a computer acquisition. However, the main focus in this article is upon hardware acquisition.

Justification

The computer acquisition process begins with the identification of one or several problems which may require a computer for their solution. It may be obvious that a computer is needed. For example, a state or school district might mandate that all students are to become computer literate, and that computer literacy instruction shall include a certain number of hours of hands-on experience. Or, a business, math, or science text that has been adopted for a school may include a substantial unit requiring use of computers.

Typically, however, it is not so easy to justify computer acquisition. More commonly the problems that have been identified can be attacked by more than one means. For example, a school system may have test data indicating that students are weak in basic skills. There are computer programs that can be used to work on this type of problem. But there are other approaches, such as textbook selection, teacher training, increased time allocated to basic skills, etc. Why is it that computers should be used to attack this problem?

As another example, consider a social studies teacher who wants his/her students to experience the situation of coping with a complicated social studies problem. The teacher is aware of computer simulations and that students enjoy working with computer simulations of social studies problem areas. But clearly there are alternatives, such as reading appropriate books, carrying on class discussions, viewing a movie, or making use of a non-computerized simulation. Why is it that computers are needed?

Many people have given careful thought on general reasons why computers are needed in our schools. A brief summary of some of the general argument is given in the Arguments section of this ES3 report. Studying these general justifications can help one to understand why computers are important in education. But it is still necessary to study one's own educational setting and to carefully justify any proposed computer acquistion.

Needs Assessment

A needs assessment is a careful study of the proposed use of computers to determine the nature and extent of the facility that will be needed. Suppose, for example, that it has been decided to offer a computer science course in a high school, and that enrollment is to be limited to 20 students. The course is to include substantial use of library programs as well as instruction in a particular programming language. The library programs that students are to run will be written by the teacher in the summer before the class begins. Students in the class will need two hours of computer access per student per week. About one-third of this access must come during the time the class meets. The class meets an hour per day, five days per week.

Analysis of the above situation points to the need for a computer system with an adequate secondary storage mechanism. There will need to be a minimum of three keyboards of access (three terminals to a timeshared system or three microcomputers, for example). The facility will need to be accessible to students both during the computer science class and at other hours throughout the day.

Notice that there are many different computer systems that can meet these needs. This is a desirable situation, since it allows one to shop around for a reliable vendor who offers good service and equipment at a reasonable price.

The nature and extent of a needs assessment will vary with the complexity and size of the problem. Suppose that a school wants to acquire a very modest computer facility so that two teachers can begin to teach themselves a little about computers. The school has at most a thousand dollars to spend. It would not make sense to spend several thousand dollars of time in a needs assessment for this acquisition.

But consider the alternative of a large school district planning to acquire several million dollars of computer facility. Now the needs assessment will take many thousands of hours of people's time. The final documents, detailing the nature of the needed computer facility, may be several hundred pages long.

A very important part of needs assessment is long term planning. One's computer facility needs will change with time; likely they will grow in size and complexity. The needs assessment must address this issue. One may want a facility that can be added to via increased primary or secondary memory, new languages, more or different terminals, etc.

The results of a needs assessment can be written into a "request for proposal" (RFP). An RFP is sent to vendors interested in supplying computer facilities. It is a basis for detailed proposals offering to supply specified facilities at certain prices. It is important that an RFP be written so that more than one vendor can meet the needs it details. This leads to competition, both in price and in the nature and quality of services offered. It is quite educational to study the proposals that various vendors will submit. The proposals may lead to a reconsideration of the needs, and possibly to a rewriting of the needs assessment. Remember that one is under no obligation to accept any of the proposals that are received.

General Financial Planning

Financial planning usually goes on concurrently with the justification and needs assessment steps. One must have some idea of how much money is available and how much various types of facilities cost in order to carry out an appropriate needs assessment. If one has only a few thousand dollars available it makes little sense to send out an RFP that can only be met by a million dollar computer system.

A common error in financial planning is to think only of the initial direct cost of the computer facility to be acquired. Here are some more things to think about.

1. The needs assessment, general planning, writing of specifications, dealing with vendors, evaluation of bids, supervision of installation, and so on take considerable time and expertise. Who will do this, and at what cost?

2. The acquired facility will need to be housed. What will site preparation cost?

3. Computers use supplies, such as paper, tapes, disks, and so on. Who will make sure that these are available as needed, and who will pay for them?

4. Computers need to be maintained and repaired. Who will check out the machine if something goes wrong, what provisions will exist for maintenance and repair, and who pays for this? A standard estimate is that for large computers a maintenance contract costs about 0.75 percent of the total cost of the equipment per month. This amounts to $7,500 per month on a million dollar computer system. For less expensive computer systems, such as microcomputers, perhaps 2 percent per month is a reasonable estimate of potential maintenance and repair costs beyond the first year.

5. Large computer systems require operators and usually require a programming staff. Such staff can easily cost as much as the rental of the computer system they are operating.

6. Teachers may need to be trained, curricula may need to be revised, courseware may need to be developed.

7. Software may need to be revised, developed, or acquired. The software will need to be maintained and distributed. Over the long run this can easily cost more than the original cost of the computer facility. Who will do these things, and who will pay for it?

The list could be expanded, but it is already long enough to make the point. One should make an estimate of the useful life of the equipment to be acquired and of all expenses associated with this life. The amount of "up front" money needed may be quite modest compared to the overall expense. Can one justify the overall expense?

The Acquisition Process

Renting or purchasing computer equipment through a school district is generally subject to a considerable amount of red tape. Approval may need to be gained at the school building level, the school district level, and at some higher level such as an educational services district or state level. The procedure to be followed in preparing specifications and going out for bids often have to meet rules laid down by various regulatory agencies.

We can offer two general types of advice here. First, enlist the aid of appropriate administrative personnel in completing the paperwork and procedures required by the various levels of school districts. Second, handle the overall request for bids in a relatively formal and professional manner. The larger the acquisition the more care needs to be spent on both points.

There can be a considerable financial gain to preparing careful specifications and going out for bids from a number of vendors. This is true even if you have decided that there is only one brand of equipment that will meet your needs. If there is more than one vendor of this brand of equipment, there can be competition. If there is competition for the contract, there is likely to be price cutting. Of course if you are purchasing a single $600 microcomputer, you can't expect much concession from a dealer. But if you are purchasing $25,000 worth of microcomputers, you may well be able to get a 10 percent to 20 percent discount. If you are acquiring a million dollar computer system and a particular vendor is very eager to get your business, you may well get a larger discount.

Knowledge About Computers versus Size of Acquisition

For convenience in the remainder of this presentation, we divide people into three categories, based upon their knowledge and experience in the computer field.

1. People with a modest or very low level of knowledge about computers.
2. People with a medium amount of knowledge about computers.
3. People with considerable knowledge about computers.

It is not important to give precise definitions to these three categories. However, a person who has had formal coursework and/or experience equivalent to only one or two computer courses or less is probably in the first category. Professionals, with knowledge and experience equivalent to a master's degree in computer science or more, are in the third category. You can decide for yourself which category best describes you.

It is also convenient and instructive to divide computer acquisitions into three sizes.

A. A small acquisition, such as a few microcomputers or a corresponding amount of timeshared computer facility.

B. A medium acquisition, perhaps for a single large school or for a small school district. This could well range from $5,000 up to $100,000 in magnitude.

C. A large acquisition, perhaps to meet the needs of a large school district or a statewide educational organization. The amount of money involved could range up into the millions of dollars.

The exact dividing lines between categories are not important.

Taken together the two sets of classifications form a three by three matrix.

		Size of Acquisition		
		Small	Medium	Large
Knowledge and Experience	Low	1A	1B	1C
	Medium	2A	2B	2C
	High	3A	3B	3C

Suppose, for example, that you are in cell 1C of the matrix. You know relatively little about computers, but you are considering a large acquisition. You should see the obvious...that this is not a good situation. At the other end of the scale consider the 3A person. Such a highly knowledgeable person does not need the aid of this short article to make a small acquisition. The main advice offered in the remainder of this article will focus upon the categories 1A, 2B and 3C.

Advice to Level One People

Level One people have little or no knowledge about computers. It is doubtful if a Level One person can do an adequate justification and needs assessment for the 1B or 1C situation. Thus if you are in the 1B or 1C situation you should probably do three things. First, start studying the computer field. Second, hire a professional consultant. [illegible]rd, involve other educators from your school district in the overall task.

In hiring a consultant use common sense. Find one who is experienced, who doesn't have a particular ax to grind, and who can produce good references. (A particular consultant may have a predisposition towards acquiring a particular vendor's equipment or have other biases of this sort.) Remember that you are intending to spend a good deal of money in a field about which you know next to nothing. You will be highly dependent upon the consultant. You should be prepared to spend a significant amount of time in selecting a consultant, and a significant amount of money in hiring the consultant. Also, you will need to continue to learn more about the field, and to carefully study the consultant's work.

Suppose that you are in the 1A category. You don't have much money to spend, you have limited knowledge, and (hopefully) you have limited goals. There are two general categories of equipment available to you. You might tie into an existing timeshared educational computer network. Or, you might acquire one or more microcomputers. A very good thing to do is to find several people who have similar goals and who have already acted to start reaching the goals. If timeshared computing facilities are a viable alternative, then you should be able to find several educators who are using the system. Talk to them, and seek their advice. Are they satisfied with the service, and is it solving their problem?

If microcomputers appear to be the answer, find some teachers using microcomputers in a setting somewhat similar to the one you envision. If at all possible, try to view several different brands of machines in use.

Overall what you are doing is trying to make use of a free consulting service. Each person you visit and talk to is a consultant. Be aware that they are likely to be biased (it could be towards or against their current equipment) and likely do not have a broad general overview of the range of potential solutions to your problem. However, likely they are interested in helping you solve your problem and may well contribute substantial time to helping you. They may be able to provide you with inexpensive or free access to software that you will need.

In this search for "free" consultants you may well want to talk to vendors. But be sure to talk to some non-vendors. Also, be aware that a vendor is particularly interested in solving your problem with the type of equipment that he/she sells or rents.

In summary, you are making a rather limited acquisition. Thus, you will likely put a rather limited amount of effort into it. Whatever your decision, acquire only something that already exists and which you can both see in action and try out beforehand. Do not be the pioneer. As a rank amateur, you should be following in other's footsteps.

Advice to Level Two People

Level Two people have a medium amount of computer knowledge and experience. If the problem you face is of type 2A then you have adequate knowledge to solve it. Indeed, the 1A people will be coming to you, and will think of you as an expert. Still, you know that you are not an expert. Thus, you will want to do a careful needs assessment and a careful study of the range of potential equipment. This can be a valuable learning experience, and it can be fun.

We need to say a little more about what distinguishes a Level A from a Level B or Level C acquisition. At the B and C levels one needs very careful long term planning. The maintenance and repair budgets will be substantial. Quite a bit of equipment needs to be housed. There will be many users, so there is need for quite a variety of software. The computer will be used in many courses, so many teachers need to be trained and much curriculum revision is necessary. A classroom teacher, no matter how knowledgeable, is not in a position to cope with these problems. Central administration must be involved.

At the 2B level a school or school district should consider release time for a teacher who is to be the computer expert. The types of activities listed above can easily be a half time or full time job, depending upon the amount of curriculum work to be done, and so on. If a school or district is not willing to make this sort of staff commitment, it is not clear that they should acquire the computer equipment.

The 2C situation again calls for outside help. As a very rough rule of thumb when one is considering a medium scale computer acquisition, one should think of spending perhaps 10 to 20 percent of the cost of the proposed equipment in the overall acquisition pro[illegible]s. That is, for a $30,000 acquisition you might put in $3,000 to $6,000 of people's time doing the needs assessment and studying the range of equipment that might be acquired. For a large scale acquisition one might spend 5 to 10 percent of the cost of the equipment in the study. Thus, acquisition of a million dollar computer system might be backed up by $50,000 or more of people's efforts. A needs assessment and study on this scale requires several people and quite a long time span. It is too large a burden to place on a single individual--especially one with only a medium level of computer knowledge and experience.

When following the above general guidelines, you should be aware that substantial amounts of people's time can be available at no direct added cost. The proposed users of a computer system can do quite a bit of the needs assessment as part of their regular job, and/or as part of their discretionary workload. But the overall coordination of the task can be quite time consuming and is not readily done by a person who is carrying a full time workload as a teacher or administrator of other projects.

Finally, be aware that the percentage guidelines are very rough and may not apply to your situation. Suppose your school district intends to acquire 500 identical microcomputers. The effort going into this project will not be too much larger than that needed to acquire 50 identical microcomputers.

Advice to Level Three People

The Level Three person is likely a computer professional, working full time in the computer field. This person has no trouble with the 3A acquisition, and can easily head up a 3B acquisition given the necessary time. We will restrict our attention to the 3C situation.

Over the long run it appears that education will be best served by a distributed computing system. This will be a combination of a centrally located timeshared computing system and distributed microcomputers and/or microcomputers that can serve as intelligent terminals and also as stand alone systems. Many instructional tasks can be accomplished on a microcomputer, and the capabilities of these machines will continue to grow rapidly over the next five to ten years. However, many instructional tasks require access to very large data bases, very large primary memories, very fast CPUs, etc. The communication aspects of timeshared computer systems are critical to some applications.

The design and development of an appropriate educationally oriented distributed computing system is a difficult task. Although some progress has occurred in higher education computing networks and in the Minnesota Educational Computer Consortium network, this type of progress tells us relatively little about what a public school system should be doing. Thus, a person in the 3C situation is faced with a substantial research and long term planning project. Outside consulting help, support of a strong staff, and plenty of time to devote to the project are all highly desirable.

A school district that commits itself to having a substantial amount of computing equipment should also commit itself to providing a substantial amount of money for continuing "people-oriented" support of the system. Every year new teachers will need to be trained and teachers who have previously been trained will need to refresh or upgrade their skills. There will be a continuing need to develop or acquire new software, revise and improve curriculum, and so on.

Many school districts currently make extensive administrative use of computers, and the amount of instructional use of computers is growing rapidly. Currently a school system making extensive administrative and instructional use of computers may be spending 2 percent of its budget in this area, with approximately equal expenditure in the two categories. If teaching about computers and teaching using computers continues to increase in importance, then one can expect that this 2 percentage figure will prove to be quite inadequate. A school system needs to give careful thought before it commits itself to the long term continuing expenditure of such amounts of money.

Conclusion

The acquisition of instructional computer facilities can be a difficult and time consuming task. It is best done by people with quite a bit of knowledge about computers who have had experience in computer acquisition. But there are relatively few such people working in the precollege educational environment. Thus, most schools and school systems that intend to acquire computers do not have staff with the needed level of expertise.

This article offers some suggestions. Above all, use common sense! A computer system, once acquired, will be with you for many years. You will invest much money in teacher training, software development or acquisition, and curriculum development. Much of this cost will be specific to the particular type of equipment you acquire. That is, much of your expenditure may be wasted if you suddenly decide to get rid of the equipment you have and acquire a substantially different type of gear. Thus, equipment acquisition should be based upon a very careful needs assessment and planning that looks well into the future.

References

Many computer-oriented magazines and journals carry reviews of computer hardware and software. If you are considering a major acquisition of microcomputers, you would be well advised to take a look at the latest Microcomputer Report of the Minnesota Educational Computing Consortium. The 1979-80 report was about 90 pages long and sold for $10 to Minnesota educators, $13.33 to people outside of Minnesota. Write to MECC, 2520 Broadway Drive, St. Paul, MN 55133. Another excellent source of information on microcomputers is the AEDS Journal, V 13 #1, Fall 1979, Special Issue on Microcomputers: Their Selection and Application in Education. The cost is $10 from AEDS, 1201 Sixteenth Street, N.W., Washington, D.C. 20036.

OHIO REGIONAL CONFERENCES ON MATHEMATICS EDUCATION

Conference Evaluation Form

Select the single best answer for you to each question and mark all answers on the answer sheet. If the question is not appropriate, leave it blank.

Participant Position

1. Are you:
   - A. Superintendent
   - B. Supervisor
   - C. Principal
   - D. Mathematics Education (College Level)
   - E. Teacher

Conference Objectives and Purposes

2. How clear were the objectives or purposes of this conference. The objectives and purposes:
   - A. Were clearly outlined from the beginning.
   - B. Became clear as the conference developed.
   - C. Became somewhat clear as the conference progressed.
   - D. Were referred to only indirectly.
   - E. Were never made clear.

3. The agreement between the announced purpose of the conference and what was actually presented was:
   - A. Superior
   - B. Above average
   - C. Average
   - D. Below Average
   - E. Poor

Organization

4. How well was the conference organized?
   - A. The conference was extremely well organized and integrated.
   - B. The conference was adequately organized.
   - C. The conference had less organization than would seem desirable.
   - D. The conference had no apparent organization.
   - E. The conference was too tightly organized; there was not enough flexibility to meet participant needs and desires.

5. Concerning the mixture of participants, do you think:
   - A. The mixture was about right.
   - B. There should have been more superintendents.
   - C. There should have been more supervisors.
   - D. There should have been more classroom teachers.
   - E. The groups should have met separately.

Conference Content

6. How well did this conference contribute to your professional needs?
   A. Made a very important contribution.
   B. Was valuable, but not essential.
   C. Was moderately helpful.
   D. Made a minor contribution.
   E. Made no significant contribution.

7. How would you rate the usefulness of the Resource Packet materials?
   A. Extremely valuable.
   B. Very useful.
   C. Useful.
   D. May be of use.
   E. Useless.

Participant Participation

8. How clearly were your responsibilities in this conference defined?
   A. I always knew what was expected of me.
   B. I usually knew what was expected of me.
   C. I usually had a general idea of what was expected of me.
   D. I was often in doubt about what was expected of me.
   E. I seldom knew what was expected of me.

Presenter-Participant Relationships

9. Do you feel that the presenters were willing to give personal help in this conference?
   A. I felt welcome to seek personal help as often as I needed it.
   B. I felt free to seek personal help.
   C. I felt he or she would give personal help if asked.
   D. I felt hesitant to seek personal help.
   E. I felt that he or she was unsympathetic and uninterested in participant problems.

10. Freedom of participation in conference meetings: questions and comments were:
   A. Almost always sought.
   B. Often sought.
   C. Usually allowed.
   D. Seldom allowed.
   E. Usually inhibited.

Conference Effectiveness

11. Did the conference help prepare you to lead in-service activities on microcomputers?
   A. Definitely.
   B. It was some help.
   C. It was little help.
   D. It was no help.

12. Would you recommend this conference to a good friend whose interests and background are similar to yours?
    - A. Recommend highly.
    - B. Generally recommend.
    - C. Recommend with reservations.
    - D. Definitely not.

13. How would you rate your understanding of microcomputers as a result of this conference?
    - A. I learned a lot.
    - B. My understanding improved.
    - C. A few ideas were new to me.
    - D. I learned very little.
    - E. I learned almost nothing.

14. How would you rate the presenters' sensitivity to what you consider to be the important problems in school mathematics?
    - A. They were well aware of the important problems.
    - B. They were aware of these problems.
    - C. They had a general idea of the problems.
    - D. They had a vague knowledge of some problems.
    - E. They did not seem informed of significant problems.

15. How would you rate the presentations, in general?
    - A. Outstanding and stimulating.
    - B. Very good.
    - C. Good.
    - D. Adequate, but not stimulating.
    - E. Poor and inadequate.

16. Would you like to attend conferences on other (like these) topics in this geographic area?
    - A. Definitely.
    - B. Yes, but in a bigger city.
    - C. It would be a good idea.
    - D. Probably not.
    - E. Definitely not.

17. How would you rate the use of instructional media in this conference?
    - A. The uses of media were almost always effective.
    - B. The uses of media were usually effective.
    - C. The uses of media were sometimes effective.
    - D. The uses of media were seldom effective.
    - E. The uses of media were never effective.

18. Do you believe that the conference helped establish (or improve) positive linkages between school system personnel and college mathematics educators?
    - A. Definitely.
    - B. Somewhat.
    - C. Very little improvement.
    - D. No improvement.
    - E. The linkages should not be established.

PLEASE TEAR OFF THIS PAGE AND TURN IT IN WITH YOUR ANSWER SHEET.

1. Best features of the conference were:

2. Worst aspects of the conference were:

3. I would suggest the following:

4. Were there materials on display that you would like to see included in the Resource Packets? (Which ones?)

5. Do you feel you are prepared to lead in-service activities on microcomputers for teachers? Can you tell us what activities you expect to organize? For how many teachers? When?

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